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LAKE BROWNWOOD MODIFICATION PECAN BAYOU WATERSHED, COLORADO RIV--ETC(U)
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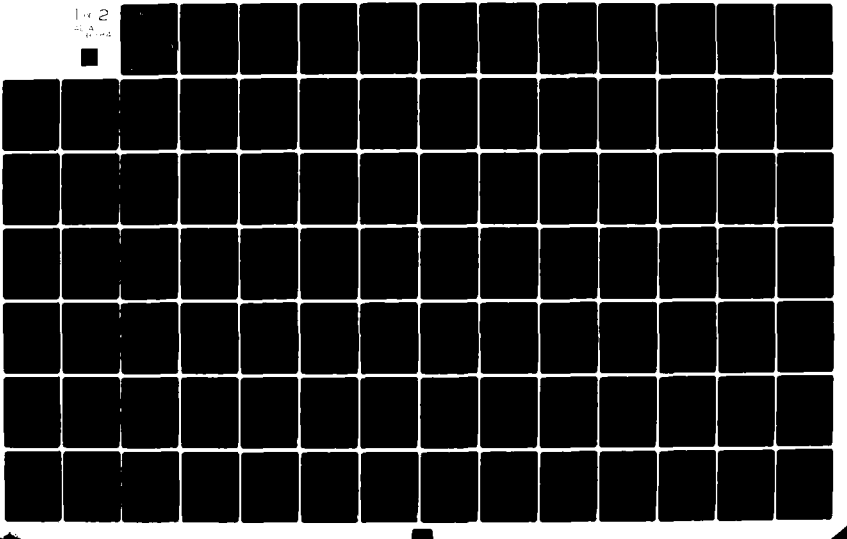

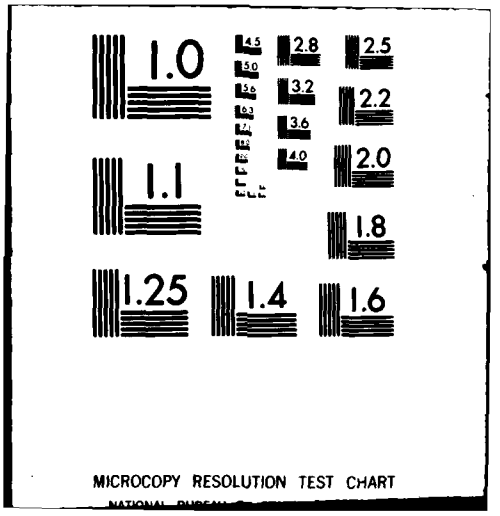
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ENVIRONMENTAL IMPACT STATEMENT

AD A096184

A

LAKE BROWNWOOD MODIFICATION
PECAN BAYOU WATERSHED
COLORADO RIVER BASIN, TEXAS

U.S. ARMY ENGINEER DISTRICT, FORT WORTH, TEXAS
SEPTEMBER 1974

181

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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4. TITLE (and Subtitle) Lake Brownwood Modification Pecan Bayou Watershed, Colorado River Basin, Texas.	5. TYPE OF REPORT & PERIOD COVERED Environmental Impact Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U. S. Army Engineer District, Fort Worth	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer District, Fort Worth, Texas P. O. Box 17300 Fort Worth, Texas 76102	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Colorado Fiver Basin, Texas
Environmental Impact
Lake Brownwood

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Draft environment impact statement which reviews proposed construction of a new embankment for Lake Brownwood. The embankment would stabilize the existing spillway to preserve present values of the lake for flood control, water supply, recreation and other related purposes. But much of the flora would be removed if the dam were constructed; lake fishery would replace the stream oriented ecosystem, and the terrestrial fauna would be displaced; however, most of the large animal inhabitants are migratory. Social patterns of the residents would be temporarily disrupted, but input of Federal funds will promote community growth.

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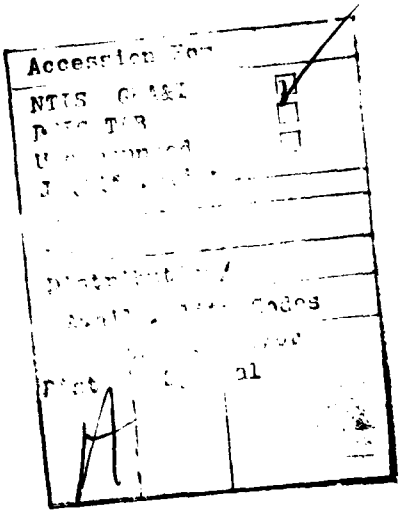
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Archaeological resources in the project area may be subjected to adverse impact unless salvaged prior to construction. There are no historical sites affected by the project.

An additional feature in a contract award for this project will include special provisions which will require the contractor to prepare an environmental protection plan to prevent environmental pollution during construction operations. Thus, the contractor will have the major responsibility to protect the environmental resources in connection with the project's construction.

Lake Brownwood modification project was authorized in the Flood Control Act of 1968 (Public Law 90-483) which was approved 13 August 1968. This authorization stemmed from the recommendations of the Chief of Engineers in House Document No. 90-350. The 1968 act amended the Flood Control Acts of 18 August 1941 and 22 December 1944, which provided for enlargement of the existing dam and improvement of the existing spillway.



SUMMARY

LAKE BROWNWOOD MODIFICATION
PECAN BAYOU WATERSHED
COLORADO RIVER BASIN, TEXAS

(X) DRAFT ( ) FINAL ENVIRONMENTAL IMPACT STATEMENT

RESPONSIBLE OFFICE: U. S. Army Engineer District, Fort Worth, Texas
Colonel Joe H. Sheard, District Engineer
P.O. Box 17300
Fort Worth, Texas 76102
Telephone: 817-334-2301

1. NAME OF ACTION: (X) ADMINISTRATIVE ( ) LEGISLATIVE

2. DESCRIPTION OF ACTION: Construct a new embankment for Lake Brownwood and stabilize the existing spillway to preserve present values of the lake for flood control, water supply, recreation, and other related purposes.

3. (A) ENVIRONMENTAL IMPACTS: The proposed plan would require about 1,000 feet of streambed below the existing dam which would be inundated or replaced by the new dam. Natural vegetation on 83 acres of land would be removed including mainly oak, mesquite, cottonwood, and various grasses and forbs. Fauna of the aquatic ecosystem of the short stretch of stream would be displaced by the dam and inundation. A lake fishery would replace the stream oriented ecosystem which exists. Some terrestrial fauna would be displaced by construction activities, but most large animals which inhabit this area are migratory. Multilevel water releases from the lake would improve wetland quality and aquatic habitats in the downstream area. A new dam for the lake would alleviate present fears of dam failure, while the input of Federal funds into the area will promote community growth. Social patterns will be temporarily disrupted due to the relocation of one mile of county road and 3,500 feet of power and telephone lines.

There are three sites of archeological significance within the proposed borrow areas which would be adversely affected unless salvage of these materials occurs prior to construction. There are no historical sites of Federal, State, or regional significance which will be affected by the project.

(B) ADVERSE ENVIRONMENTAL EFFECTS: About 1,000 feet of intermittent stream and associated natural cover and aquatic-oriented animal species would be eliminated with this plan. Natural vegetation on 83 acres of land would be removed for the location of a new dam. Approximately one mile of county road and about 3,500 feet of power and telephone lines will be required to replace the 2,000 feet of existing lines. Tax receipts and income from the small area required will be lost for the life of the project. The archeological resources in the project area may be subjected to adverse impacts.

4. ALTERNATIVES TO THE PROPOSED ACTION:

(A) No action.

(B) Removal of the existing dam.

(C) Building of a new dam.

5. COMMENTS REQUESTED:

Environmental Protection Agency

U.S. Department of Agriculture

Soil Conservation Service

Forest Service

Agricultural Research Service

Agricultural Stabilization and Conservation Service

U.S. Department of Commerce

National Weather Service

Deputy Assistant Secretary for Environmental Affairs

National Marine Fisheries Service, NOAA

U.S. Department of Health, Education, and Welfare

Environmental Impact Coordinator

U.S. Department of Housing and Urban Development

Environmental Clearance Office, Region VI

U.S. Department of the Interior

Office of Environmental Project Review

Bureau of Sport Fisheries and Wildlife

Bureau of Reclamation

U.S. Department of Transportation

Federal Highway Administration, Fort Worth, Texas

Federal Highway Administration, Austin, Texas

Advisory Council on Historic Preservation

Federal Power Commission

Office of Economic Opportunity

Director, Division of Planning Coordination, Office of the Governor

Texas State Historical Survey Committee

Texas Highway Department, Paris, Texas

Texas Highway Department, Dallas, Texas

Texas Highway Department, Wichita Falls, Texas

West Central Texas Council of Governments

Brown-Mills Soil and Water Conservation District 523

Central Colorado Soil and Water Conservation District 517

Coleman County Water Control and Improvement District No. 1

Brown County Gazette

Brownwood Bulletin

Texas Committee on Natural Resources

Citizens Environmental Coalition

Sierra Club, Lone Star Chapter

The Nature Conservancy

National Wildlife Federation

Izaak Walton League of America, Inc.

Environmental Defense Fund

National Audubon Society

Texas Archeological Salvage Project, University of Texas

Archaeology Research Program, Southern Methodist University

Sportsmen Clubs of Texas

Environmental Information Systems Office

6. DRAFT STATEMENT TO CEQ _____ .

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SECTION 1 - PROJECT DESCRIPTION

1.01 Specific Location. Lake Brownwood is located on Pecan Bayou in the north central part of the Colorado River Basin near the geographical center of the State of Texas (plate 1-1). The dam is located at river mile[g] 57.1, a short distance below the confluence of Pecan Bayou and Jim Ned Creek. Lake Brownwood is situated in the north central portion of Brown County and about 10 river miles upstream from the city of Brownwood, Texas. The proposed project, i.e., a new dam, will be located approximately 700 feet downstream of the existing Lake Brownwood dam on Pecan Bayou (plate 1-2).

1.02 Physical Description. The new dam will be a rockfill structure, and would cover about 83 acres in land area when completed. The embankment will have side slopes basically 2.5 horizontal to 1 vertical. Outlet works will consist of a 10-foot diameter gated conduit.[g] Facilities will also be included for the water supply outlet works such as a gate tower and a 5.0 foot diameter conduit through the right abutment of the new dam. The conduit will intersect the existing canal just below the dam. The existing 480-foot broad-crested concrete spillway weir[g] will be left intact; but downstream of the weir, concrete curtain walls will be constructed to protect the exposed alternate layers of shale and limestone and prevent erosion in the channel. The loose boulders and rubble within the spillway channel will be removed and utilized as protective stone along the abutments of the concrete weir and for filling the deep gouges within the channel. The existing dam at Lake Brownwood will be

NOTE: Throughout this document, "g" denotes a technical term defined in the GLOSSARY.

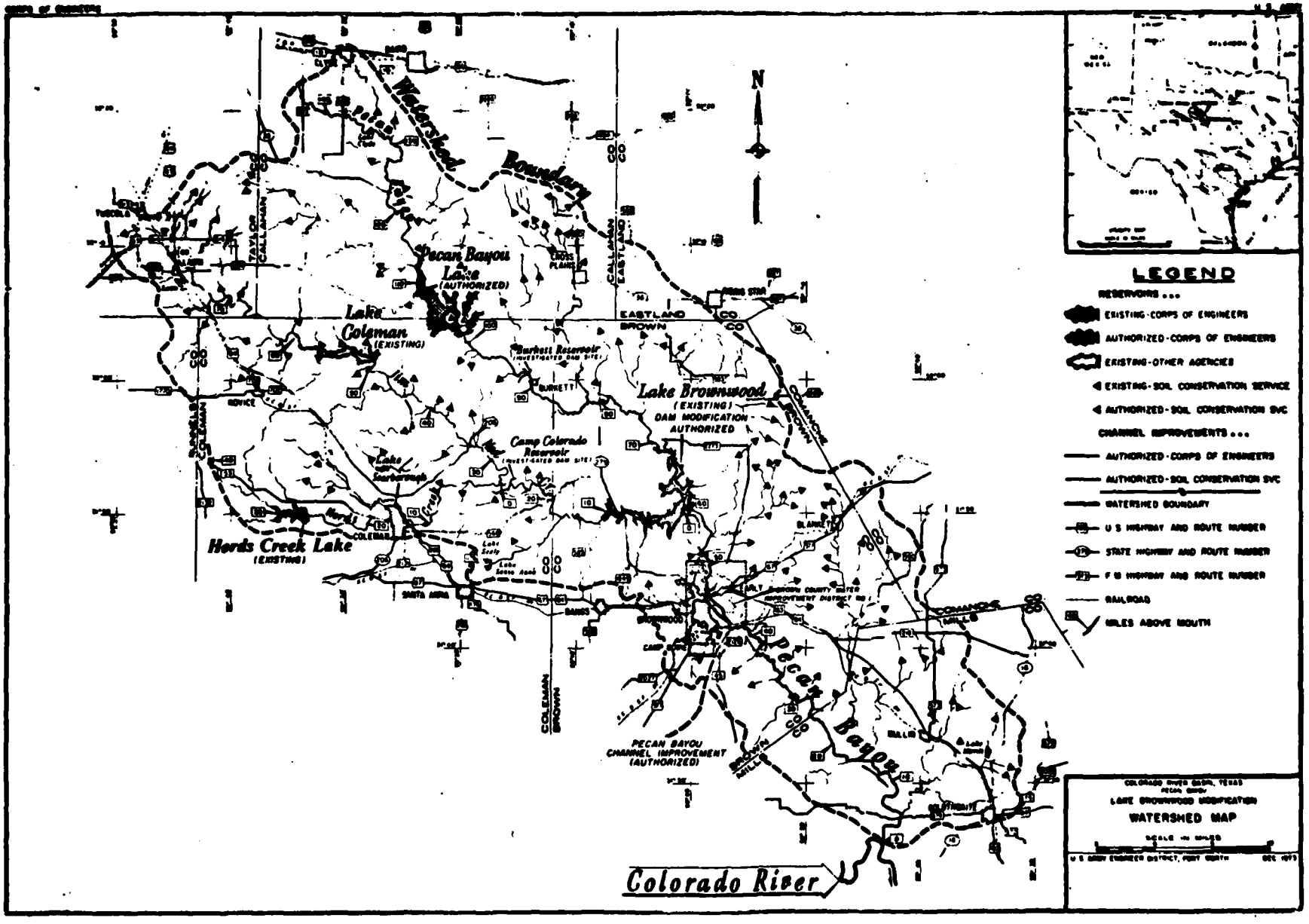

Watershed Boundary
Pecan Bayou Lake (AUTHORIZED)
Lake Coleman (EXISTING)
Burkett Reservoir (INVESTIGATED DAM SITE)
Lake Brownwood (EXISTING) DAM MODIFICATION AUTHORIZED
Camp Colorado Reservoir (INVESTIGATED DAM SITE)
Lake Santa Anna
Hords Creek Lake (EXISTING)
PECAN BAYOU CHANNEL IMPROVEMENT (AUTHORIZED)
Pecan Bayou
Colorado River
N
TAYLOR CALLAHAN
CALLAHAN EASTLAND
EASTLAND BROWN
COLEMAN BROWN
COLEMAN
BROWN
CONCHO
LEGEND
RESERVOIRS ...
EXISTING - CORPS OF ENGINEERS
AUTHORIZED - CORPS OF ENGINEERS
EXISTING - OTHER AGENCIES
EXISTING - SOIL CONSERVATION SERVICE
AUTHORIZED - SOIL CONSERVATION SVC
CHANNEL IMPROVEMENTS ...
AUTHORIZED - CORPS OF ENGINEERS
AUTHORIZED - SOIL CONSERVATION SVC
WATERSHED BOUNDARY
U S HIGHWAY AND ROUTE NUMBER
STATE HIGHWAY AND ROUTE NUMBER
F M HIGHWAY AND ROUTE NUMBER
RAILROAD
MILES ABOVE MOUTH
COLORADO RIVER BASIN, TEXAS
PECAN BAYOU
LAKE BROWNWOOD MODIFICATION
WATERSHED MAP
U S ARMY ENGINEER DISTRICT, FORT WORTH
DEC 1973

PLATE I-1

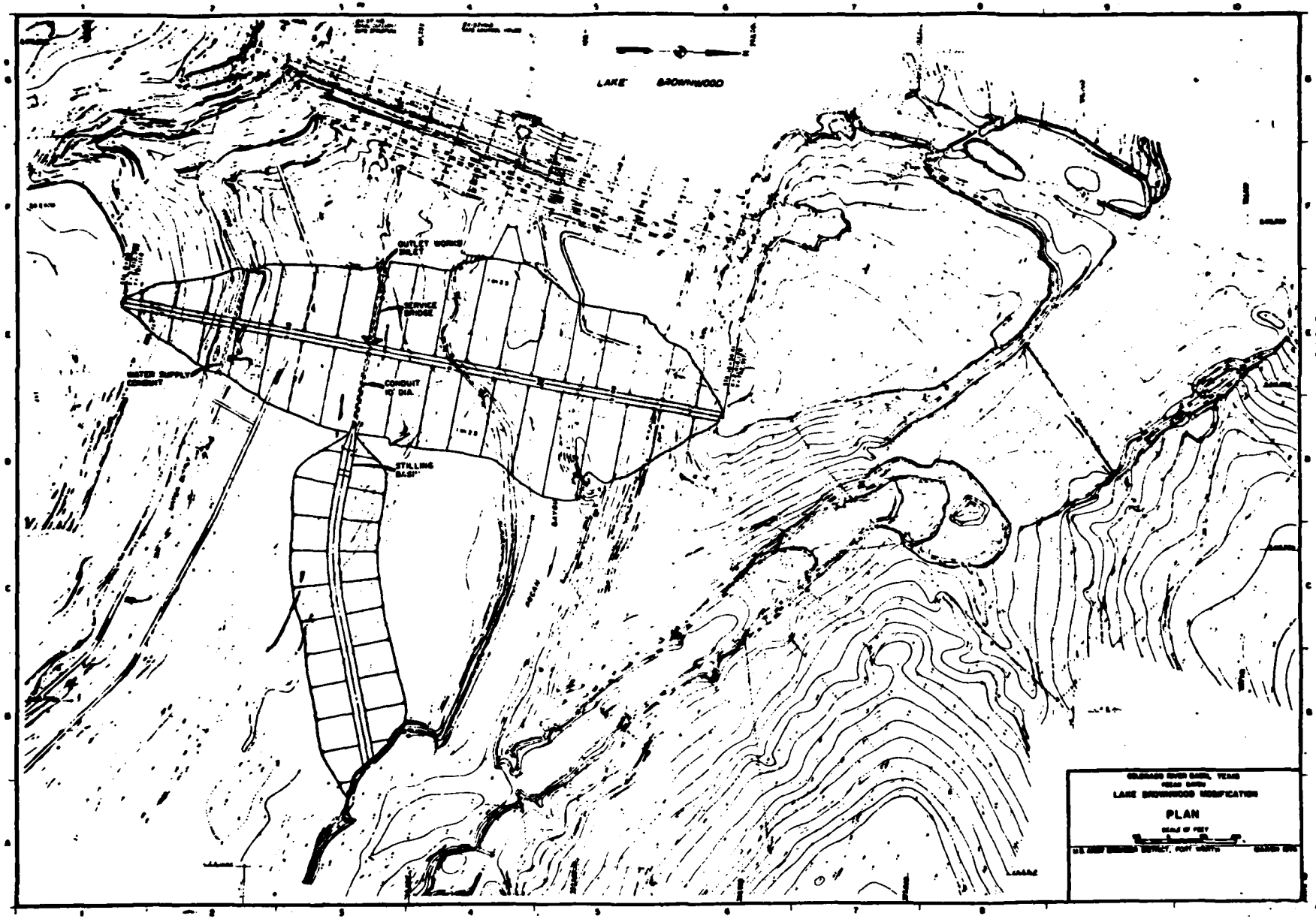

LAKE BROWNWOOD
OUTLET WORKS
SERVICE BRIDGE
CONDUIT
STILLING
LAKE BROWNWOOD MODIFICATION
PLAN

PLATE I-2

partially removed after most of the new dam is in place. Materials removed will lower the elevation of the present dam to a point below the normal drawdown[g] elevation of the lake so that it does not pose a boating hazard. Near the inlet structure for the new dam, more material will be removed from the old dam to form a cut which will be lowered below the elevation of the invert of the outlet works[g] (1370.0 feet msl). Pertinent data concerning the recommended plan of improvement are summarized in table 1-1.

1.03 Purposes. The authorized purposes of the Lake Brownwood modification project are to continue the current flood protection to suburban and urban lands along Pecan Bayou and continue to supply water for municipal, agricultural, and industrial uses.

1.04 Proposed Plan of Improvement.

(a) Benefits to be Provided by the Project.

(1) Flood Control. In order to determine the flood control effects of Lake Brownwood and assign benefits to the proposed project, flood plains below the dam were investigated. These flood plains consist of areas that would be flooded by a recurrence of the maximum flood of record[g] without the modifying effect of Lake Brownwood. The areas include 30,846 acres on Pecan Bayou between the mouth and the Lake Brownwood Dam (river mile 57.1) and 21,639 acres on the Colorado River between river miles 436.0 and 513.7 (the limits of the apparent effects of floodflows originating in the upper portion of the Pecan Bayou watershed). Average annual benefits from flood control are approximately $1,749,200.

Table 1-1

Pertinent Data - Recommended Plan of Improvement

Miscellaneous	
Dam location	
Stream	Pecan Bayou
River mile	57.1
Drainage area, square miles	1,544
Spillway Design Flood	
Peak inflow, cfs	648,500
Volume, acre-feet	1,606,300
Volume, inches	19.51
Peak outflow, cfs	347,300 (1)

Reservoir	Elevation (feet msl)	Area (acres)	Capacity (acre-feet)
Top of dam	1470.0	-	-
Maximum design water surface	1464.7	31,030	825,200
Top conservation pool	1425.0 (2)	7,570	118,900*
Sediment storage	1425.0	-	33,000

*Includes 33,000 acre-feet for 100-year sediment storage

Dam	
Embankment details	
Type	Rock fill/impervious core
Total length, feet	1,820
Height above streambed, feet	130
Freeboard, feet	5.3
Crownwidth, feet	30
Side slopes	
Upstream	2.5:1
Downstream	2.5:1
Spillway section	
Type	Broadcrested weir
Net length at crest, feet	480
Outlet works	
Type	Gated conduit
Size	One - 10-foot diameter
Outlet works (for water supply)	
Type	Gated conduit
Size	One - 5-foot diameter

(1) No discharge through outlet works
(2) Spillway crest elevation

(2) Water Supply. The city of Brownwood and other small communities in the immediate vicinity are dependent on the continued existence of Lake Brownwood as their primary water source because ground water cannot be relied upon to meet long range needs. Existing surface water reservoirs close to Brownwood are also limited in scope.

The water supply storage[g] at Lake Brownwood is about 85,900 acre-feet[g] and covers approximately 7,570 surface acres. The increase in this capacity resulting from the proposed project is negligible. Average annual water supply benefits are about $951,600.

Based on 1970 estimates of 100 years sedimentation, Lake Brownwood currently has a dependable yield of 30.0 cubic feet per second (cfs). Lake Coleman has a dependable yield of about 9.0 cfs, Hords Creek about 1.1 cfs, and other ground water developments have about 0.6 cfs. Therefore, the present dependable yield of the watershed is about 41 cfs. With the addition of Pecan Bayou Lake upstream, the dependable yield would be increased to about 47 cfs. However, the total water requirements for municipal, industrial, and agricultural irrigation, as well as water quality control in the Pecan Bayou watershed, are expected to be about 50.8 cfs in the year 2020 and about 66.4 cfs in the year 2070.

(3) Recreation and Fish and Wildlife. By taking action to reduce the existing threat of dam failure, thus preserving the existing recreation and fish and wildlife value of Lake Brownwood, the proposed project has been credited with the economic benefits

expected to be provided in 100 years of continued operations of Lake Brownwood for the additional purposes of recreation and fish and wildlife. Average annual benefits are approximately $642,600.

(b) Land Requirements. Land to be involved in the construction of the proposed project includes about 31 acres of pecan orchards and 52 acres of hilly upland. This acreage, totaling approximately 83 acres, is required for the placement of the proposed dam and outlet works. An additional 265 acres of borrow area[g] (located just south of the new dam and on the north side of Pecan Bayou one mile downstream) will provide the suitable material for the earthen dam. There are no additional land requirements for recreation areas or project facilities.

1.05 Authorizing Document. The Lake Brownwood modification project was authorized in the Flood Control Act of 1968 (Public Law 90-483) which was approved 13 August 1968. This authorization stemmed from the recommendations of the Chief of Engineers in House Document No. 90-350. The 1968 act amended the Flood Control Acts of 18 August 1941 and 22 December 1944, which provided for enlargement of the existing dam and improvement of the existing spillway. The Flood Control Act of 1968 authorized three projects for the Pecan Bayou watershed. The projects include Pecan Bayou channel improvements beginning about 10 miles downstream of Lake Brownwood for local flood protection at Brownwood, Texas; Pecan Bayou Lake on Pecan Bayou approximately 40 miles upstream of Lake Brownwood for purposes of flood control, water supply, recreation, and fish and

wildlife enhancement; and Lake Brownwood Modification to insure the safety of the existing dam against deterioration and failure and preserve the existing values of Lake Brownwood for flood control and water supply, as well as other related purposes. Lake Brownwood modification provides for construction of a new dam and outlet works downstream of the existing dam, and for stabilization measures for the existing spillway channel.

1.06 Status. The Lake Brownwood Modification project is in the advanced engineering and design stage.

1.07 Benefit-Cost Ratio. Based on an interest rate of 3.25 percent and using July 1974 price levels and a 100-year amortization period, the benefit-cost ratio for this project is 3.4 to 1.0. A summary of economic data is presented in table 1-2.

Table 1-2

Summary of Economic Data*

First costs		$21,295,000
Average annual charges		979,500
Average annual benefits		3,343,400
Flood control	($1,749,200)	
Water supply	($951,600)	
Recreation	($642,600)	
Benefit-cost ratio		3.4 to 1.0**
		$(B/C = \frac{\$3,343,400}{979,500} = 3.4)$
Excess annual benefits over annual costs		$2,363,900

*ECONOMIC DATA EXTRACTED FROM U.S. ARMY CORPS OF ENGINEERS PHASE I GENERAL DESIGN MEMORANDUM, LAKE BROWNWOOD MODIFICATION, PECAN BAYOU, COLORADO RIVER BASIN, TEXAS. COMPLETE DOCUMENT IS AVAILABLE AT U.S. ARMY ENGINEER DISTRICT, FORT WORTH, TEXAS.

**Nonquantifiable environmental benefits and costs are not reflected in this benefit-cost ratio.

1.08 Operation and Maintenance. Once the Lake Brownwood Modification project is complete, the local sponsor, Brown County Water Improvement District No. 1, will assume the responsibility to operate and maintain the dam and water supply works. They will operate the flood control features of the project in accordance with regulations prescribed by the Secretary of the Army. There are no postconstruction programs incorporated within the scope of the proposed project modification plan by the Corps of Engineers.

1.09 Environmental Protection. The contract awarded for this project will include special provisions which will require the contractor to prepare an environmental protection plan to prevent environmental pollution during construction operations. Thus, the contractor will have the major responsibility to protect the environmental resources in connection with the project's construction. Included in the technical specifications are criteria for the prevention of air, water, and noise pollution, and of land despoilment from spillage and waste. Prevention of air pollution includes consideration of dust, smoke, fumes, and sprays. Criteria for prevention of water pollution cover spilling fuel, oil, and grease; runoff from concrete operations; sanitary and other waste disposal operations; asphalt operations; and from the use of herbicides and pesticides. Land despoilment considerations include spillage and waste from concrete, asphalt, and water curing operations, and the destruction of land forms and vegetation. Noise pollution as a result of all construction, sediment control, and clearing and grubbing operations is also covered by technical specifications.

SECTION II - ENVIRONMENTAL SETTING WITHOUT THE PROJECT

2.01 Physiographical Description.

a. Lake Brownwood is located on Pecan Bayou in the north central portion of the Colorado River Basin. The Colorado River Basin extends from the Lea-Chavez County line in the southeast portion of New Mexico some 600 miles in a southeasterly direction across the State of Texas to the Gulf of Mexico. The Basin is bounded on the east and north by the San Bernard and Brazos River Basins and on the west and south by the Pecos, Nueces, Guadalupe, and Lavaca-Navidad River Basins. The cities of Big Spring, Odessa, and Midland are located in the upper flat semiarid region of the Basin. The city of San Angelo lies in the middle of the Basin, and just east of San Angelo is the city of Brownwood and the Pecan Bayou watershed.[9] In the lower portion of the Colorado River Basin is the capital city of Austin where the Basin narrows to about 30 miles in width as it begins to funnel toward a narrow outlet at the Gulf of Mexico. The Basin has an area of 42,344 square miles, and Pecan Bayou watershed covers about five percent of this area.

b. The Pecan Bayou watershed is bordered on the north and east by the Clear Fork and Leon River watersheds of the Brazos River Basin, and on the west and south by the small lateral tributaries of the Colorado River. The watershed has a maximum length of about 85 miles, a maximum width of about 40 miles, and a drainage area of 2,202 square miles. Upstream from the Lake Brownwood Dam, the watershed contains about 1,544 square miles.

c. The Lake Brownwood area is included in the West Cross Timbers geographic region of the Interior Plains physiographic province. The province is characterized by terrain consisting of rolling plains with moderate relief from relatively smooth plains to sharply eroded valleys.

2.02 Geological Elements.

a. Geomorphology.[9] The subject project lies within the Osage Plains region, a subdivision of the Great Plains geographic province. The region is bounded on the west by the Llano Estacado, on the south by the Edwards Plateau and Central Mineral region, on the east by the Grand Prairie, and on the north by the Red River uplift. The region is underlain by near flat lying sedimentary rock strata[9] of Pennsylvanian and Permian ages. Topographic relief in the western part of the region is moderate. The area is characterized by gently rolling hills and occasional buttes which are capped by erosional remnants of resistant Cretaceous age limestone. The Lake Brownwood damsite and northeastern portion of the subject watershed are underlain by an erosion resistant escarpment which has evolved into a more rocky and rugged topography. At the damsite the topography is characterized by parallel, ridge-like undulations extending northeast to southwest. The ridges are rocky and heavily wooded, while the intervening valleys are mantled with greater soil depths and are under extensive cultivation (8).

b. Rock and Mineral Features.

(1) Stratigraphy.[9] The Pecan Bayou and Jim Ned watersheds

are underlain by Pennsylvanian and Permian age strata which strike[g] northeast to southwest and dip approximately 60 feet per mile to the northwest. The dam and major portion of Lake Brownwood are founded on deposits of the Canyon group of Pennsylvanian age. The Canyon group represents the oldest rocks which crop out in the project area. The group consists of alternating limestone and shale beds with minor amounts of fine-grained sandstone. From oldest to youngest, the group includes: the Graford, Winchell, Brad, and Caddo Creek formations. The Canyon group has a total thickness of about 650 feet in the study area. The upper reaches of Lake Brownwood are underlain by strata for the Cisco group of Pennsylvanian age. Lithologically,[g] the Cisco consists primarily of shale with a few limestone interbeds.[g] The group of sediments forms an outcrop pattern approximately 6 miles wide trending northeast to southwest across northwestern Brown County. The Cisco group includes the Graham and Thrifty formations which have a combined thickness of about 285 feet. The upper one-third of the Lake Brownwood drainage basin[g] is underlain by Permian rocks of the Wichita group. Regionally the Wichita group includes seven formations; however, in Brown and Coleman Counties, only the lower two are present. Lithologically, the two formations, Pueblo and Moran, are similar to the underlying Cisco group, except that they contain a larger percentage of channel-fill[g] sandstone deposits. The formations are also characterized by conglomerate beds[g] and typical Permian red beds. In this area the Wichita group has a total thickness of about 500 feet.

(2) Petroleum Sources. Large quantities of oil and gas have been produced in the project area. The limits of the fields are poorly defined and are listed by the Railroad Commission of Texas as the Brown County Regular and Coleman County Regular fields. Production is primarily from sandstone beds of the Canyon and Strawn groups at depths of about 1,500 feet. Most of the sandstone bodies are believed to be channel-fill type deposits. Thus, the lateral extent of the oil producing sands is erratic (28).

(3) Construction Materials. Several small sand and gravel pits are presently operating in the area. These materials are used locally for road construction and maintenance. It appears that some of the Permian limestones found at or near the surface in the area would be of commercial thickness and quality for use as crushed stone in general construction. No commercial mineral deposits are presently being exploited within the limits of the proposed damsite modification.

c. Ground Water. Within the study area ground water occurs erratically in shallow, discontinuous zones in the Pennsylvanian and Permian rocks, and in the Pleistoscene to Recent alluvial[9] deposits found at the surface in the lower elevations. The most dependable wells are completed in the Pennsylvanian and Permian strata of depths ranging from about 50 to 200 feet.

d. Structure. The geologic structure of the project area is relatively simple. The Pennsylvanian and Permian strata have a general strike of about N. 25° E. and dip toward the northwest

approximately 60 feet per mile. A few high hills and buttes which are capped by erosional remnants of Cretaceous age limestone are present in the area. The Cretaceous rocks formerly covered the Pennsylvanian and Permian strata and are nearly horizontal with a very slight dip to the southeast. Regionally the Brownwood Lake and drainage basin are located on the west flank near the apex of the Bend Arch. This structural feature has a north-south trend and extends north from San Saba County to northern Young County. No major faults have been mapped or recorded within the project limits.

e. Geology of the Damsite. Limestone strata present adjacent to the embankment site will allow the construction of a rock fill embankment with an impervious compacted soil core.[g]

f. Soil Profile.

(1) General. The soil profile in the study area consists of Recent stream alluvium and older terrace deposits[g] which are found at considerably higher elevations than the present streams. Generally the upland and ridge areas exhibit only a thin residual soil mantle. The Recent alluvium and terrace deposits vary in thickness from only a few feet to as much as 40 feet in the stream channels. The terrace deposits are generally coarse grained sand and gravel, while the Recent alluvium is predominately clay (25).

(2) Permeability.[g] All of the soils in the Lake Brownwood area have slow permeability, indicating high runoff rates (25).

(3) Erosion. Soils in the project area are not generally classed in a high erosion potential group, but the clays and loams of

the more flat upland prairies and lowland flood plains are subject to erosion if the natural vegetative cover which develops is disturbed. The stony hills, rocky hills, and sandstone hills are more stable except for pockets of soils which develop that may be subject to erosion. Where clays are uncovered, they can crust severely and cause a high rate of runoff and ersoion (25).

(4) Soils Descriptions. Soils which exist in the project area (25) include primarily the Bonti, Callahan, Sagerton, Krum, Frio, Owens, Throck, Speck, Winters, and Rochelle series (table II-I). Lowlands in the area concern mostly the Frio and Krum series, which are clays and loams of low permeability. They have moderate to severe limitations for roads, playgrounds, camping, picnicking, and path and trail development. The shrink-swell[9] potential of these soils is great, and flooding also causes problems. Uplands are associated with the Callahan, Rochelle, Sagerton, Speck, Throck, Winters and Bonti series. Bonti soils are found on sandy hills. They are shallow soils with bedrock close to the surface. Some stoniness provides limitations as well as those imposed by the sandy nature of the soils. The Callahan, Owens, Sagerton, Speck, and Throck series are associated with clay and clay-loam upland soils which are mostly slowly permeable, have extreme shrink-swell potential, and a clay texture which provides moderate to severe limitations for most types of surface development. The Winters and Rochelle series are sandy-loam soils on uplands, with slight to moderate limitations because of their somewhat slow permeability.

Table II-1

Soils Descriptions

Name	: Density, Color	: Type Soils, Subsoils	: Location	: Topography	: Slope	: Range on Site
Bonti associations	fine, brown	fine sandy loam over red and yellow acid clays	Uplands mainly ridgetops	hills	1 - 8%	sandstone hills
Callahan	fine, reddish brown	heavy loam over reddish brown and yellow alkaline clays	level to gently undulating valleys	upland valleys	1 - 5%	claypan
Frio	fine, dark grayish brown	silty clay throughout calcareous and moderately alkaline throughout	flood plains	flat	frequently flooded	loamy bottomland
Krum	fine, very dark grayish brown	silty clay throughout, calcareous and moderately alkaline	stream terraces, upland valleys	flat to gently rolling	1 - 3%	clay loam
Owens	Light olive brown	clayey soils underlain with shale or shaly clay. Calcareous and moderately alkaline throughout	narrow ridge divides and side slopes	hilly	steep 1 - 25%	rocky hills

Table II-1 (continued)

Name	Density, Color	Type Soils, Subsoils	Location	Topography	Slope	Range on Site
Rochelle	reddish brown	sandy loam over sandy clay loam	undulating uplands	rolling	1 - 5%	sandy loam
Sagerton	brown	clay loam throughout	uplands and ancient stream terraces	rolling	1 - 3%	clay loam
Speck	brown to reddish brown	clay loam underlain by limestone	level to gently sloping low ridges	flat	1 - 3%	redland
Throck	brown	silty clay over massive olive gray clay	sloping uplands	rolling	1 - 5%	shallow clay
Winters	reddish brown	sandy loam over sandy clay and clay loam	level uplands	flat	1 - 3%	sandy loam

2.03 Hydrological Elements.

a. Drainage Area. The pear-shaped Pecan Bayou watershed has a drainage area of 2,202 square miles. The watershed has an overall length of 85 miles and a maximum width of 40 miles and slopes generally from northwest to southeast. Included in the drainage area are portions of eight counties: Taylor, Runnels, Coleman, Callahan, Brown, Eastland, Miller, and Comanche.

b. Climatic Conditions. The climate in the Pecan Bayou watershed is temperate, with hot summers and cool winters. Freezing temperatures and snowfall are experienced occasionally. Mean annual temperature in the watershed is about 65 degrees F, with January having an average minimum daily temperature of approximately 33 degrees F. August, the warmest month, has an average maximum daily temperature of approximately 97 degrees. The average relative humidity at midnight is 66 percent; at 6 a.m., 75 percent; at noon, 48 percent; and at 6:00 p.m., 47 percent. The average length of the growing season, between killing frosts, is about 235 days, and the average wind velocity is about 13 miles per hour from a southerly direction.

(1) Precipitation. The mean annual precipitation over the Pecan Bayou watershed is 27 inches, ranging from 23 inches in the headwaters region to 29 inches near the mouth. Snowfall is an insignificant portion of the total precipitation. Extremes of annual precipitation recorded at Brownwood have ranged from a maximum of 46.00 inches in 1919 to a minimum of 10.86 inches in 1921. The

normal seasonal distribution of rainfall over the watershed is generally favorable for agricultural purposes.

(2) Storms. The three types of storms that cause precipitation in the Pecan Bayou watershed are thunderstorms, frontal storms,[g] and cyclonic storms. The greatest storms that have been experienced in the Pecan Bayou region are frontal storms. The major flood producing storms occurred September 20-24, 1900; October 5-6, 1930; October 12-14, 1930; July 3, 1932; and April 30-May 22, 1956. The September 1900 storm produced rainfall of 12.57 inches over a period of 120 hours. The 1932 storm produced 12 inches of rainfall.

c. Runoff. Currently in operation in the Pecan Bayou watershed are five stream-gaging stations, two reservoir gages, and one canal gage. Streamflow regulation afforded by the existing Lake Brownwood and Hords Creek Lake has greatly affected the runoff from the drainage areas above the stream-gaging stations during most of this operation. The following tabulation summarizes the annual runoff at the stream-gaging stations in the Pecan Bayou watershed. The runoffs shown are the observed runoffs and have not been corrected for reservoir storage, evaporation, or diversions.

Station	Drainage Area (sq mi)	Period of Record*	Annual Runoff (acre-feet) Maximum:	Minimum:	Average
Hords Creek near Valera	52	1947-1970	5,480		1,310
Hords Creek at Coleman**	108	1940-1970	23,950		6,290
Pecan Bayou at Brownwood		1924-1928			
	1,622	1929-1970	563,000	3.600	112,300

*Water year, October through September.
**Gage became inactive in October 1970.

d. Channel Capacities. Channel capacities of Pecan Bayou vary from approximately 30,000 second-feet[9] near the mouth to about 12,000 second-feet in the vicinity of the Brownwood gage, and from approximately 13,000 second-feet at river mile 68 (the head of Brownwood Lake) to 10,000 second-feet at the Pecan Bayou damsite.

e. Evaporation. Evaporation losses from the reservoirs in Pecan Bayou watershed were estimated from the correlation between precipitation and evaporation for the middle Colorado River watershed. This correlation was determined by analysis of data recorded at three evaporation stations situated adjacent to the central Colorado River watershed area, San Antonio (1907-1930), Temple (1915-1959), and Spur (1916-1959). The following table shows the net annual evaporation loss from a reservoir surface corresponding to selected annual precipitation for the Pecan Bayou watershed.

Table II-2

Correlation Between Precipitation and Net Evaporation Loss From a Reservoir Surface

Annual Precipitation (inches)	Net Annual Evaporation Loss (inches)
15	54.0
20	45.8
25	37.9
30	30.2
35	22.6
40	15.1
45	7.7
50	0.8
55	-6.2

f. Floods. Frequent flooding occurs in the Pecan Bayou watershed from April through October. The greatest known flood in the Pecan Bayou

watershed above the existing Brownwood Dam occurred July 3, 1932. The peak discharge on Jim Ned Creek for the 1932 flood was 187,000 second-feet near the head of Lake Brownwood. The greatest known flood at the Brownwood gage prior to construction of Lake Brownwood occurred in September 1900, reaching a stage of 21.7 feet and an estimated peak discharge of 150,000 second-feet. Since early 1932, with the completion of Brownwood Dam, Lake Brownwood has modified all floods originating in the Pecan Bayou watershed, while floods on Hords Creek have been modified by the Hords Creek Lake since 1948.

g. Flood Control. Flood problems on Pecan Bayou result from frequent heavy rainfall in the 2,202 square mile watershed. The major floods which occur cause extensive flood damages to agricultural properties in the valleys of Pecan Bayou and its principal tributaries. They also contribute to flood damages along the main stem of the Colorado River. However, the principal flood problem in the watershed lies in the city of Brownwood. There, urban development in the flood plain of Pecan Bayou and the tributary streams, Adams Branch and Willis Creek, is subject to appreciable damages from frequent floods. Substantial flood protection for the tributary streams has been provided by Soil Conservation Service programs, but additional flood control measures are needed to reduce anticipated flood damages along Pecan Bayou. Included in potential flood problems is the inadequacy of the dam at Lake Brownwood and the potential flooding which could occur if the dam were overtopped with a severe flood in the watershed.

Soil Conservation Service plans call for a total of 90 floodwater retarding structures in the upper Pecan Bayou, Turkey Creek, and Jim Ned Creek watersheds. About 71 of these structures are complete or under construction. Hords Creek Lake, a multipurpose Federal project, modifies flooding on Hords Creek, and Lake Coleman on Jim Ned Creek is a water supply lake that has had little effect on attempts to control flooding in the watershed. All of these structures have a collective effect on flooding in the watershed.

h. Water Supply. Available water supply for industrial, municipal, and agricultural uses in the Pecan Bayou watershed is limited, and several attempts have been made to alleviate this problem by developing surface water impoundments. The supply of ground water in the area is also limited, and a history of inadequate water supply has been experienced. Lakes which have been developed with water supply storage include: Hords Creek Lake, Lake Scarborough, and Lake Coleman (which provide municipal water for the city of Coleman); Lake Brownwood (which provides water for agricultural irrigation and municipal usage for Brownwood, Early, Bangs, and Santa Anna); Lake Clyde (a Soil Conservation Service structure which also provides water for the city of Clyde); and other small reservoirs with less than 1,000 acre-feet storage capacity such as Lawn Lake, Lake Merritt, Lake Sealy, and Lake Santa Anna.

i. Water Quality - Lake Brownwood. There are no cities within the immediate drainage area of the reservoir whose stormwater drains

to the lake. There have been no known instances of degradation of the lake attributable to urban runoff. There are no known natural occurrences of salt domes, sulfates, or other materials that might result in contamination of waters. The Railroad Commission of Texas surveyed oilfield activity with regard to possible pollution or contamination of freshwater supplies, both surface and ground water, revealing no associated contamination or pollution. Moderate farming activity utilizes irrigation, and for all practical purposes there is very little, if any, return flow to the stream. Among the solid waste disposal sites in the area, there are no facilities which are known to be creating a pollution threat. There has been moderate development around the lake. Efforts are underway to avoid contamination of the lake by septic tanks. Air drying of sludges on sludge drying beds has proven acceptable in this area. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area. Currently, there are no Texas Water Quality Board water quality monitoring stations on the lake. The lake water is suitable for contact and noncontact recreation, propagation of fish and wildlife, and domestic, industrial, and agricultural raw water supply (35).

2.04 Biological Elements.

a. Flora. The plant community in the general area is comprised primarily of a mixture of mid to short grasses, medium to small trees, low shrubs and vines, and some cacti. The grasses include mainly different species of bluestem, grama, and three-awn. The more

dominant trees are various species of oak and elm as well as mesquite, mimosa, hackberry, and pecan. Typical shrubs and vines include several species of sumac, some hawthorn, buckthorn, greenbrier, grape, and poison ivy. Prickly pear and yucca are also prevalent. There are no known plant species considered to be rare, endangered, or threatened in the general proposed project area (20). A more comprehensive list of the characteristic plant species in the area is incorporated in appendixes A and F.

b. Fauna. The animal community in the general area is composed of different species of mammals, amphibians, reptiles, birds, and fishes. The rather commonplace assemblage of mammals is comprised mainly of carnivores, bats, and rodents. The amphibians and reptiles include several customary species of frogs, toads, turtles, lizards, skinks, and snakes. The variety of bird species is fairly large, ranging from eagles to hummingbirds. Typical fish species for the area are represented by those present in Lake Brownwood. These include mainly rough fish, such as gizzard shad, river carpsucker, and buffalo, although game fish, such as largemouth bass, white crappie, and several sunfish are available. There are no known animal species considered to be rare, endangered, or threatened in the general proposed project area (3).

Listings of the mammals, amphibians, reptiles, birds and fish reported to occur in the general area are contained in appendixes B through E.

c. Air Quality. The air quality in the Lake Brownwood area

meets the national primary and secondary ambient air (the outdoor air around us) quality standards. This conclusion is based on the data presented as a result of ambient air sampling for the year 1972 by the Texas State Department of Health (34).

2.05 Archeological Elements. Archeological findings represent the prehistoric remains of the life and culture of a people who once inhabited the area. Remains may include prehistoric villages, dwellings, and objects used in everyday activities. Four archeological sites were found in the area immediately below the existing dam during an investigation by the Archeology Research Program, Southern Methodist University. One site was located in the vicinity of the proposed dam. It has been generally scattered by farming practices, but flakes, chips, cores, and burned limestone chunks can be observed there. In the opinion of the archeologist in charge of the investigation, this site did not warrant further investigation. Three other sites were located in the area which would provide borrow materials downstream from the dam. These sites are locations of temporary campsites of Archaic age people, and the remains are mostly lithic debris, fire-cracked rock, and mussel shells. The archeological report concluded a pit testing program is desirable to assess the depth of deposit at the three sites and to determine the importance of each site (23).

2.06 Historical Elements. Eastern Apaches, called Lipans by the Spanish, inhabited the Brown County area before and during the reign of Spain over Texas. These Indians were determined fighters

who often raided white settlements. Later, the even more formidable Comanches pushed the Apaches westward and became the inhabitants of the Brown County area. They caused a tremendous amount of trouble for the white men whose settlements were expanding during the period between the founding of the Republic of Texas and the Civil War. Reports reflect that the Pecan Bayou streams were favorite camping spots for the Comanches. A large camp was located just west of the western boundary of Brown County. Favorite westward travel routes crossed along Pecan Bayou and to the south, a few miles from the present site of Brownwood.

The first Spanish soldiers arrived in 1723 in Brown County, where they battled an Apache force north of the Colorado River. The Spaniards formed expeditions into Indian occupied land to recapture horses and mules, which were the favorite booty of raiding Indian bands. The Spanish came to the Brown County area again in 1759 to revenge the massacre of inhabitants of the San Saba Mission near the town of Menard. The expedition crossed Brown County moving northwest to a Comanche stronghold in Montague County, but they suffered defeat and retreated to the presidio on the San Saba.

Captain Henry Stephenson Brown, for whom the county was named, came to the area also seeking stolen livestock that the Indians had taken from his party near Gonzales. He led a group of men up the Colorado River, crossing near the mouth of Pecan Bayou into Coleman County where they raided a large Indian encampment and recaptured a majority of his livestock.

The first settler in the county was Welcome W. Chandler, who arrived with his family in 1856. J. H. Fowler drove the first cattle herd into the county that same year. Brown County was created by an act of the Texas Legislature August 27, 1856, and Brownwood was designated the county seat.

From this time until the cattle boom period which started in the late 1860's, Indian raids were numerous, as were retaliatory raids made by the white settlers. However, Indian raids diminished after 1866, and only scattered small bands of Indians were left in the area. They were nomadic stragglers with a purpose, however, and their raids were extremely fierce. These Indian raiding parties resulted in the formation of a battalion of Texas Rangers in 1874 expressly for the purpose of protecting the white settlements. The Rangers succeeded in clearing the area of most of the remaining Indian raiders.

Longhorn cattle were predominant in the area until 1880 but they were gradually replaced by the more stocky breeds from the east, and few remained by 1890. The era of the cattle empires brought gangs of rustlers and thieves into the area, including the famous outlaw gang led by John Wesley Hardin. The Texas Rangers turned their attention to these gangs and finally captured Hardin who was sent to prison.

Farmers and squatters moved into the open range country and brought about a period of fence building and fence cutting that lasted until about 1888.

Brownwood became the most prosperous town in the county because of its designation as the county seat. A railroad line was completed

in 1885, and in the succeeding years a commercial boom occurred in the city.

About 1895, interest was generated in the irrigation of farms along the Pecan Bayou. To expand the potential for irrigation from the stream a dam was proposed, but nothing was accomplished until 1924 when a water improvement district was formed. Construction of Lake Brownwood Dam began January 10, 1931. On July 3, 1932 heavy rains in the watershed threatened the unfinished dam, but the floodwaters flowed only over the spillway and through the release gates. On June 29, 1934, after the flood release gates had been used for irrigation releases, it was found that the gates would not close, and all the water in the lake was lost. After securing Federal and other loans, the irrigation system from the lake was completed in the summer of 1939. A state park was created at Lake Brownwood by the State Park Board which secured a Civilian Conservation Corps group of two hundred men who furnished the necessary labor to construct a lodge and other facilities.

Before World War II, Brown County became the building site of Camp Bowie where National Guard troops were to be trained. During the war, infantry, armor, and artillery troops were trained there and the camp was expanded to cover an area of about 5,000 acres for the actual post, and about 122,000 acres of land for maneuvers and gunnery practice. As many as 30,000 men were in training at one period during the war. When hostilities ceased in the summer of 1945, the camp was closed and sold to the former landowners or to

the highest bidders. A planned reopening during the Korean conflict never came about.

Brownwood and Brown County have prospered because of agricultural industry support. An intensive industrial park occupies part of the Camp Bowie site (11).

Many old structures of the native sandstone peculiar to the area are located in Brownwood. Historic homes, a former mill, stores, and schools exist as reminders of Brownwood's history. Camp Bowie Memorial Park has been constructed on the site of Camp Bowie and six historical markers are located within the county. These markers can be found at the McClelland Library at Howard Payne University; Camp Collier, Confederate States of America, on the courthouse grounds; at the county jail; at St. John's Protestant Episcopal Church; one for Brown County, east of the city limits of Brownwood; and one for the Swinder Pecan Orchard on the southeast side of Brownwood.

2.07 Land and Cultural Elements.

a. Population. The population in the four county area in the vicinity of Lake Brownwood decreased slightly from 1960 to 1970. Table 11-3, compiled from U.S. Census data, shows detailed population trends and ethnic composition of each county within the study area.

The immediate project area is Brown County. Lake Brownwood is located within Brown County, which had a 4.6 percent increase in population from 1960 to 1970. Estimates show a continued increase in the county population to approximately 27,500 by 1980 and 31,000 in the year 2000 (36).

Table II-3

Detailed Population Data

Population (By County)

	Brown	Callahan	Coleman	Mills	Area Totals
1960					
Urban	16,974	3,917	7,691	1,383	29,965
Rural	7,754	4,012	4,767	3,084	19,617
Total	24,728	7,929	12,458	4,467	49,582
1970					
Urban	19,679	4,365	6,918	1,693	32,655
Rural	6,198	3,840	3,370	2,519	15,927
Total	25,877	8,205	10,288	4,212	48,582

Percent Population Change 1960 to 1970 (±)

Urban	+15.9	+11.4	-10.1	+22.4	+9.0
Rural	-20.1	-4.3	-29.3	-18.3	-18.8
Total	+4.6	+3.5	-17.4	-5.7	-2.0

Population - Principal Cities

	City of Coleman	City of Brownwood
1960	6,371	16,974
1970	5,608	17,368
Percent of change 1960 to 1970	-12.0	+2.3

Ethnic Composition

	Brown	Callahan	Coleman	Mills	Area Totals
1960					
White	23,967	7,921	12,134	4,463	48,485
Negro	743	2	321	1	1,067
Other	18	6	3	3	30
1970					
White	24,797	8,187	10,000	4,193	47,177
Negro	898	3	251	0	1,152
Other	182	15	37	19	253

Percent Change Within the Study Area 1960 to 1970

White	Decrease of	2.7%
Negro	Increase of	8.0%
Other	Increase of	743.0%

(1) Distribution. Approximately 67 percent of the Brown County population in 1970 was classified as urban, with the city of Brownwood containing 17,368 inhabitants. The remaining 33 percent of the county population can be divided into a nonfarm oriented population of 23.3 percent of the total population, and a farm oriented population of 9.6 percent which represents the rural residents of the county. The residents of Brown County, both rural and suburban who participate in agricultural production, provide raw materials for which Brownwood functions as the distribution center to other areas. The city of Brownwood did not grow at a rate as fast as Brown County. From 1960 to 1970 Brownwood grew at a rate of 2.3 percent while Brown County doubled that percentage. This reflects a differing trend to that of many Texas counties where rural populations have declined as the urban areas increased in population. Many of the rural inhabitants of Brown County commute to Brownwood for jobs. The small towns of Early, Zephyr, Bangs, and the residential development around Lake Brownwood provide the potential commuter with alternate facilities and services which may or may not be less expensive than those in the city. However, these small residential developments offer other advantages such as the esthetic appeal of a country or lakeside setting in which to live.

(2) Ethnic Composition. The 1970 population of Brown County was composed of 3.4 percent Negro, 5.3 percent persons of Spanish language or Spanish surname, and 0.5 percent persons who were foreign born. Of the remaining population, a few citizens were of foreign stock representing the United Kingdom, Ireland, Germany,

Czechoslovakia, Austria, and Canada. However, 84.8 percent of the residents of the county were considered to be natives residing in their state of birth. This percentage of native residents represents a slightly higher percentage than that for the State of Texas with 72.9 percent.

b. Education and Employment. The median school years completed by residents of the four county study area is 10.8. Brown County residents had the highest median of 11.2 years completed. These figures fall below the State average of 11.6 years.

In 1972 the city of Brownwood had five elementary schools with an enrollment of 1,890 students, one junior high school with 901 pupils, one high school with a student body of 776, Howard Payne Junior College with a total enrollment of 1,525, one business college, and one beauty college.

The unemployment rate for the four county area in 1970 was 2.5 percent of the total work force. Brown County with 4.3 percent unemployment had the highest percentage in the study area. It is also higher than the State of Texas average of 3.6 percent. Brown County has a nonworker-worker ratio for the labor force of 1.51 to 1, somewhat above that for the State with 1.48 to 1.

Economic development in the four-county study area showed a total income of about $125.6 million in 1970. The main sources of income were agriculture, about $34 million; minerals, about $13 million; U.S. Government expenditures about $37 million; and the remaining income is derived from manufacturing, agri-business, tourism, and

other miscellaneous sources. The area per capita income in 1970, $2,550, was slightly less than the state average. Employment data from the Texas Employment Commission (1972) are shown in the following tabulations to help describe the present level of economic development.

Manufacturing	2,160 employed
Nonmanufacturing	1,334 employed
Agriculture	3,245 employed
Unemployed	760

Of the Brown County labor force 17.7 percent was employed by manufacturing, 44.8 percent in white collar occupations, and 11.6 percent had government jobs. The median salary in Brown County of employed persons is $6,417, somewhat lower than that for the State at $8,490. The 1970 census revealed that 14.9 percent of the population of Brown County had an income less than the poverty level, while 9.2 percent had an income of $15,000 or more. The State had 14.6 percent on the less than poverty level list and 16.5 percent on the list of those earning $15,000 or more per year.

The OBERS projections (36) to year 2020 for the four county area show that the population will increase about 27 percent between 1980 and 2020; employment will increase about 30 percent; personal income will increase about 300 percent, and earnings from agriculture will increase about 116 percent. Assuming the study area growth will approximate the economic area growth, considerable economic expansion can be expected to continue in the area along with a long term population increase.

c. Recreational Opportunities. Water based recreation opportunities existing in the Lake Brownwood area include those at Lake Proctor, approximately 40 miles to the northeast; Hords Creek Lake, about 35 miles to the west; Lake Coleman, about 35 miles to the northwest; several lakes in the Abilene area; and one near Brady, Texas, about 50 miles from Lake Brownwood. These lakes receive a large amount of visitation from local communities and some overnight, weekend, and holiday use from the larger metropolitan areas of Fort Worth-Dallas, Abilene, Midland-Odessa, San Angelo, and Lubbock. There is a recognized tendency for the residents of the western portion of Texas to travel greater distances to use water based recreation facilities because of the lack of these facilities, and the attraction of people from an arid climate to a large water body. Hords Creek Lake and Lake Proctor have characteristics similar to Lake Brownwood in terms of proximity to population centers, land and water character, and climate of the area. They differ in the type of facilities provided and the extent of development around the lakes. Lake Brownwood is surrounded by private landholdings and commercial development. On Lakes Proctor and Hords Creek large public parks surround the shoreline with free facilities such as picnicking, sanitary facilities, and launching ramps available for those who may not wish, or may not be able, to pay for the use of such facilities. Public access is more readily available under such circumstances because with only two exceptions, the ramps at Lake Brownwood are private or require a fee for use. One free ramp is provided by the

State and one by the Water Improvement District. Overall, private landownership and commercial development along the shoreline of Lake Brownwood have a limiting effect on public access to the lake.

Facilities which are available around Lake Brownwood include camping, picnicking, lodging, and commercial services for users of the lake. Lodging accommodations along the shoreline include cabins, cottages, lodge encampments, and permanent homesites. Other commercial facilities include fishing piers and docks, boat docks, and boathouses. The shoreline area has undergone extensive subdivision, and only a few areas of any size are still free from development. However, because of the character of the shoreline, with its panorama of rock bluffs, beautiful beaches, rugged hills, and vistas of relatively clear water, most of the development along the shoreline is generally well maintained and tastefully designed. The development does not detract to any large extent from the character of the lake.

As it exists, Lake Brownwood receives a visitation of about 400,000 recreation days annually. This exceeds the visitation to both Hords Creek and Lake Coleman, but Lake Proctor receives a visitation of about 620,000 recreation days annually. The visitation at Lake Proctor reflects its closer location to the Fort Worth-Dallas metropolitan area. Visitation to Lake Brownwood could reach an estimated 945,000 as an optimum visitation, but limited access will probably prevent the visitation from reaching this number. Existing and proposed public and private development around the

lake should accommodate expected increases in visitation at the lake.

d. Land Use. A 1970 land use inventory by the Soil Conservation Service (table II-4) revealed that the average amount of land area utilized for agriculture, ranching, open and undeveloped land uses in Brown, Callahan, and Coleman Counties was approximately 95 percent. Only about 2 percent of the remaining land in each of the three counties was classified as urban or developed land.

e. Transportation and Communication. Road access to the Lake Brownwood area is provided by several United States and Texas Highways. U.S. Highway 67 - 377 ties the Dallas-Fort Worth metropolitan area to the Brownwood area, and U.S. Highway 67 to the southwest ties in traffic from San Angelo. U.S. Highway 84 brings traffic from the Abilene area and ties into Interstate 20 for other traffic from the west. U.S. 283 and U.S. 377 provide access from the south toward Brady, Mason, and Fredericksburg. State Highway 279, Park Road 15, and U.S. 183 in connection with various county roads provide the actual access to Lake Brownwood. The area has various transportation modes, with Continental Trailways and Arrow Coach buslines; the Atchison, Topeka, and Santa Fe Railroad, and Texas International Airlines providing connections to most other cities. General Telephone Company of the Southwest provides telephone service for the area, and the "Brownwood Bulletin" and several local radio and cable television stations provide news for the area.

Table II-4

Land Use by County (in percent)

County	Total Area (acres)	Federal Non-cropland	Urban (builtup)	Small Water Areas	Cropland	Pasture	Range	Forest	Other Lands
Brown	667,680	0	3	.5	21	3	28	43	1
Callahan	548,096	0	2	.01	20	.07	69	8	.8
Coleman	815,814	.4	2	1	29	0	64	3	.5

f. Public Services, Health, and Welfare. Brownwood provides most of the medical services for the Lake Brownwood area. Brownwood Community Hospital has 120 beds, and the city has 17 medical doctors, 13 dentists, and 5 chiropractors. Eight nursing homes with 689 beds are also located in the city. Brownwood has a council manager form of municipal government, and provides a full range of services from police and fire departments to garbage and trash service. Brownwood Coliseum is the center for cultural activities. It provides art displays and houses touring shows by different groups of entertainers. Two libraries are provided, Brownwood Public Library and Howard Payne College Library (29).

Very limited facilities and services are provided for residential development around Lake Brownwood. Although there are telephone service and electrical lines, residential areas on the lake have no central sewage treatment facilities, no police protection other than the State Highway Patrol or the county sheriff, and no firefighting equipment nearby. They do not share other services and amenities provided to Brownwood residents. Like most lakeshore developments, only the attraction is readily available. Many such developments have no building restrictions or codes, and the resulting development lacks unity and overall esthetic appeal. Water supply for the Lake Brownwood area is provided via the lake and an extensive canal-pipeline system.

2.08 Expected Changes in the Environmental Setting in the Absence of the Proposed Project.

a. Physiography. The physiography of the study area is not expected to change dramatically in the future, but some dramatic changes could take place if certain events occur. Land uses in the area are not expected to change significantly, for the needs of agricultural production will remain intense, and the various products from this area will probably always be in demand. There could be local changes in the type of production, from livestock to grain production, or from feed to production of human foodstuffs, but no broad scale changes are expected. Some lands will change from agricultural uses to residential uses, especially for second home development, but no major residential development is anticipated. The counties surrounding Brown County have generally lost population over the last 10 years. Even though Brown County has gained in population, and projections show that it will continue on this trend, it is doubtful if residential land needs will change the land uses to any great extent. The conditions which could occur and could change the potential for physiographic transitions[g] in Brown County are related to Lake Brownwood.

Flood simulation studies have shown that the existing dam and spillway at the lake could not withstand at least two types of floods, i.e., the flood of record[g] if it occurred in a central location in the watershed, and the spillway design flood.[g] Should either of these types of floods occur, the dam would be overtopped and could fail. This would cause portions of the city of Brownwood to sustain severe flood damages of disastrous proportions. Washout of the dam would also

deposit silt and litter over a large area downstream. Flood damage would likely be in the millions of dollars and could result in loss of life. The area would be devoid of its recreational attraction unless Lake Brownwood Dam were rebuilt. If a disaster of this type occurred, the Brownwood area would suffer lasting effects of a broad magnitude.

b. Geology. No changes are expected to the surface or subsurface geological strata without the project unless the dam at Lake Brownwood should fail, and then many changes would occur in the surface geology from the erosive nature of the sudden, extreme flooding.

c. Hydrology. Without the project, the streamflow would remain intermittent below the dam as it is at present. Outflows presently in the form of water for municipal, industrial, and agricultural needs are released from the lake via a water supply canal. The water between Lake Brownwood Dam and the low-water dam within the city of Brownwood would remain stagnant during times of low flow in the Pecan Bayou watershed. However, if the dam at Lake Brownwood were to fail, about 450,000 acre-feet of water behind the dam would enter the creek and flow through the city of Brownwood (assuming that the lake elevation was at the top of the dam elevation). This would cause a change in the streambanks of Pecan Bayou because of erosion and sedimentation.[9] Sediment washed from the lakebed would be very extensive. The future flow of Pecan Bayou would then depend on whether Lake Brownwood Dam was reconstructed or whether the stream was allowed to flow naturally.

d. Biology. It is doubtful that major changes will occur in biological communities in the Lake Brownwood area in the foreseeable future. The influences of man have been occurring over a long period of time and have had a noticeable effect on the stream community.[9] An exception to this statement has been and will be more evident in the immediate area of the lake where new subdivision development is presently occurring. Here, vegetative communities[9] and wildlife habitat will probably be permanently interrupted. The popularity of hunting and fishing near the Lake Brownwood Dam area will probably increase unless the dam should fail and destroy lake and downstream fisheries. Changes would occur according to man's actions to rebuild the dam or to let the stream ecosystem[9] revert to its original state. In either case there would be a long period of transition because of the devastating flood and sediment action from such an occurrence. No fish or wildlife species or plant species now inhabiting the area is expected to become threatened.

e. Esthetics. The existing commercial and residential development in the Lake Brownwood area varies in quality from the esthetic viewpoint. Some structures are designed using the natural character of the area as a design influence, while others are designed very gaudy to attract the eye of potential users. Overall, the shoreline development on the lake does not detract from the appearance of the landscape, but this does not mean that all development is in good taste, or that the shoreline would not be more attractive without a majority of this private development. A negative appearance could develop over a period of time, slowly or quickly depending on

maintenance, as many commercial and residential developments begin to deteriorate and their value is decreased.

f. Land Use. The historical land use trend in the Pecan Bayou watershed is not expected to change drastically. As a result of the relatively low population density, significant land use changes should not occur except in special cases such as the development of new reservoirs or the introduction of new industrial concentrations.

g. Relation to River Basins, Watersheds, and Ecosystems. Lake Brownwood Dam directly influences the 2,202 square miles of Pecan Bayou watershed, particularly the 658 square mile area below the dam. Lake Brownwood also affects the Colorado River Basin but to a lesser extent. Sediment carried by streams of the Pecan Bayou watershed is captured by the lake, which reduces the magnitude of flood peaks originating above the dam, and this reduces potential flood damages along the area of Pecan Bayou below the dam and along the Colorado River.

The greatest influence of the lake is on the area immediately downstream of the dam and lake. In low water periods, water removed from the lake is used for irrigation and municipal water supply, and no flow is present in the stream area below the dam. However, a small portion of the diverted water is later returned to the stream. Some of the water used for municipal, agricultural, and industrial uses evaporates which causes some increase in local humidity, and some percolates to the water table underground. Much of the water

used for municipal purposes is returned to the stream in the form of wastewater. It is important to note that the dam and its related water supply system modifies the streamflow and the downstream riparian[9] ecosystems.

SECTION III - RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

3.01 General. The proposed project is a segment of the overall plan of flood control for the Pecan Bayou watershed as outlined in the Review of Reports on Pecan Bayou Watershed, Colorado River Basin, Texas, dated 31 December 1963. The Flood Control Act of 1968 authorized the Lake Brownwood modification to insure the safety of the existing dam against deterioration and failure, and preserve the existing values of the lake for flood control, water supply, and other related purposes.

3.02 Relationship With Existing and Planned Water Resources Developments. Major floods originating on the Pecan Bayou watershed cause extensive flood damages to agricultural properties in the valleys of Pecan Bayou and its tributaries, and contribute to additional flood damages along the main stem of the Colorado River. These adverse conditions caused an interest in studies and projects which would relieve the flood problem, as well as provide water for agricultural, municipal, and industrial uses. Lake Coleman was built on Jim Ned Creek by the city of Coleman for water supply purposes. The city of Coleman also constructed Lake Scarborough for a municipal water supply on Indian Creek, a tributary of Jim Ned Creek, which is a major tributary of Pecan Bayou.

The Corps of Engineers built Hords Creek Lake on Hords Creek, a larger tributary of Jim Ned Creek, for flood control, water supply, and recreation. Other small lakes (generally less than 500 acres in size) such as Lake Sealy, Lake Santa Anna, Lake Merritt, Lawn Lake,

and Lake Clyde, have been developed for water supply to small towns and communities in the watershed. The Soil Conservation Service has a flood detention reservoir program that includes 71 structures, existing or under construction, in the Pecan Bayou watershed upstream from Lake Brownwood, with an additional 19 structures authorized. Below the lake, 38 Soil Conservation Service flood detention projects are built or under construction, and another 12 are authorized.

The multipurpose Pecan Bayou Lake is authorized as another Corps of Engineers project. It will contain flood storage to control 50-year frequency floods originating above the damsite, a larger water supply storage capacity, and provisions for recreational development. Other projects have been studied for the watershed, but as yet have not been authorized.

The Lake Brownwood modification and the Pecan Bayou Lake projects, along with the other existing and under construction lakes, will combine to provide an effective flood control system for the watershed. As a total system, these lakes would also provide water to meet the supply needs of the watershed for the immediate future.

3.03 Coordination. The scope of the proposed project has been provided for examination to the Federal, State, and local entities shown in table III-1. Their replies, to this date, have revealed no conflicts with the objectives and terms of existing or proposed land use plans, policies, and controls. Written correspondence is included in section IX.

Table III-I

Coordination Effort - Land Use Plans

Mailing List	Reply Received
U.S. Department of Agriculture	
Soil Conservation Service	25 Apr 74
Department of Housing and Urban Development	
Region VI	7 May 74
U.S. Department of the Interior	
Bureau of Reclamation	18 Apr 74
Bureau of Outdoor Recreation	8 May 74
Environmental Protection Agency	
Region VI	13 Jun 74
Division of Planning Coordination	
Office of the Governor	2 May 74
West Central Texas Council of Governments	
Director of Regional Planning	23 Apr 74
James G. Bunnell	
Brown County Judge	
J. B. Paul	
Manager, Brown County Water Improvement	
District No. 1	
W. T. Harlow	
Mayor, Brownwood	

SECTION IV - THE PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT

4.01 Hydrological Elements.

a. Water Quality. The project related adverse impacts on water quality in the construction and downstream areas would be controlled through contract specifications which require the contractor to develop an environmental protection plan to prevent environmental pollution during construction operations. Government inspectors will insure the environmental protection plan is followed by observing activities during the construction period. As a result of this surveillance, the amount of water pollution occurring from construction materials, and from sediment that may be carried off from land clearing and moving materials should be limited. Removing a portion of the existing dam would temporarily increase turbidity and sedimentation.

Continued land developments along the periphery of the lake could affect water quality if proper techniques and regulations for waste disposal are not followed. In addition, future recreational activities on the lake and at public use areas will have the potential for degrading the quality of impounded water. Four gated intakes having sills at elevations 1389.0, 1398.0, 1407.0, and 1416.0 will be provided to permit low flow releases from selected lake levels. A low flow valve and bypass line will be provided for releases from the lake for pool levels between elevations 1389.0 and 1370.0. Selected multilevel releases can aid in providing water with more suitable temperatures and dissolved oxygen content.

b. Water Supply. The new dam will not increase the water supply of Lake Brownwood, but it will maintain the existing dependable yield of 30.0 cfs for municipal, agricultural, and industrial water supply. Although there would be no increase in existing yield as a result of the proposed project, the yield would become more reliable with the threat of dam failure removed.

4.02 Geological Elements. The principal aquifers[g] in the areas will not be affected by the proposed project modifications. There are no known mineral deposits, geological outcrops, or fossil collecting areas of special interest or significance that would be adversely affected by the project.

4.03 Biological Elements. In assessing the effects of the proposed project on existing biological elements, the general area is divided into three main sections, i.e., the upstream area, damsite area, and downstream area. The upstream area includes primarily the lake and associated aquatic and terrestrial populations. The damsite area refers more specifically to the construction area and its effects on surrounding terrestrial populations and communities. The downstream area will cover the project related effects on both plant and animal populations in the area below the proposed dam and construction activity.

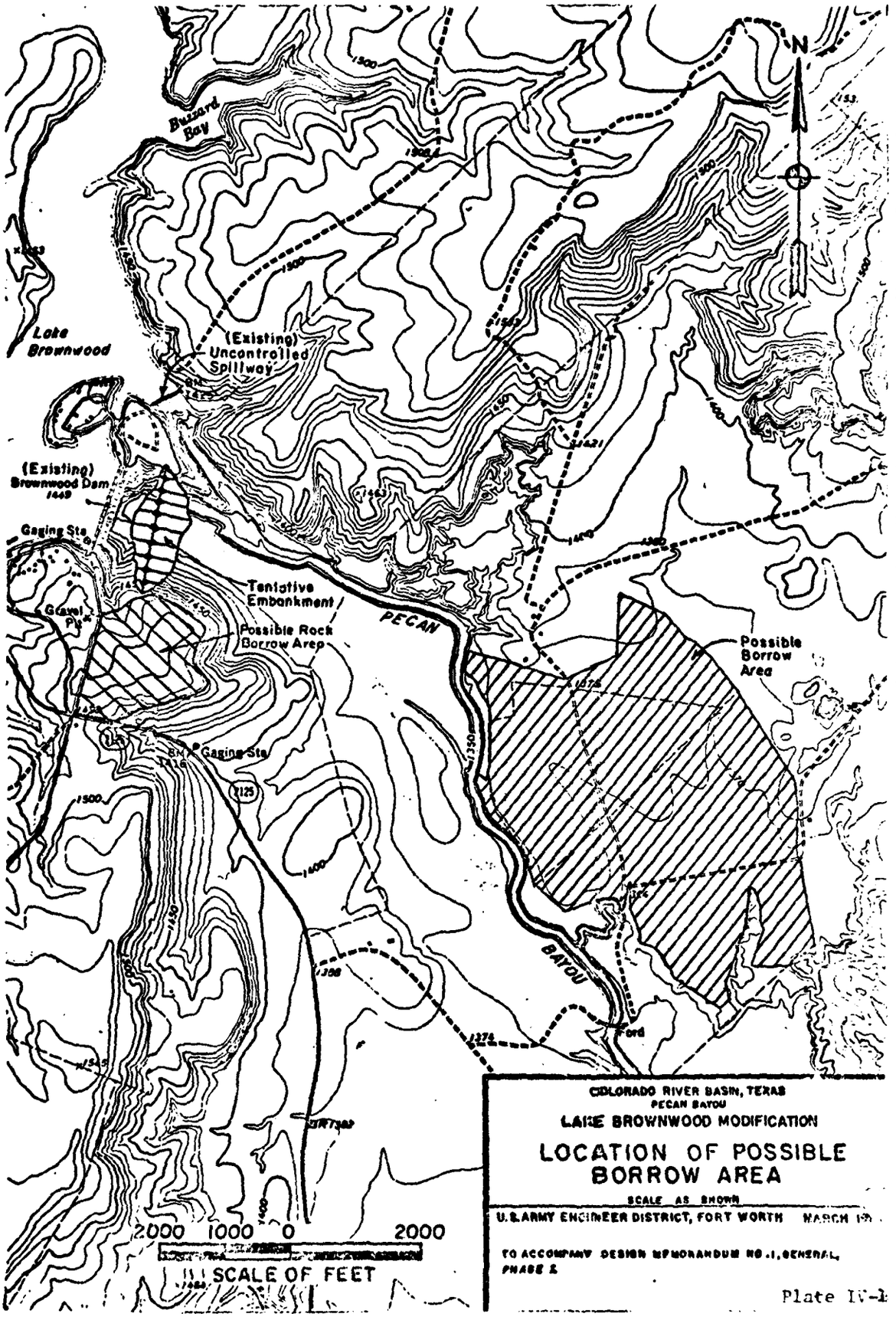
a. Stream Alteration. About 1,000 feet of the streambed below the existing dam at Lake Brownwood would either be inundated or replaced by the new dam. The natural streamflow in this section of stream below the lake has been altered by the operation of the

existing dam. With the exception of high flows over the spillway and occasional low flows through the outlet conduits, water released from the lake is transported via canal and used for irrigation and municipal water supply. The proposed project will not alter these present streamflow characteristics, resulting in very little water entering the downstream area under normal conditions, i.e., periods with no floodwaters.

b. Vegetation.

(1) Aquatic. Upstream, there would be little or no effect on existing species along the periphery of the lake. It is doubtful that there would be an increase in species along the new shoreline resulting from the proposed construction because no additional nutrients, chemical constituents, or different substrates would be involved. In the damsite area, there would be a loss of existing riparian species due to construction and inundation. Downstream, there would be very little displacement of species resulting from water releases. Past construction downstream effects should revert back to the conditions that presently exist.

(2) Terrestrial. Upstream, no change in existing populations except in areas dedicated to future developments along the periphery of the lake. At the damsite, there would be a loss of species due to construction, inundation, and/or clearing procedures. There will be an elimination of species in the borrow areas (plate IV-1). However, these areas will be sloped to provide drainage, and no ponding areas will be left unless specifically



COLORADO RIVER BASIN, TEXAS
PECAN BAYOU
LAKE BROWNWOOD MODIFICATION

LOCATION OF POSSIBLE BORROW AREA

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, FORT WORTH MARCH 19

TO ACCOMPANY DESIGN MEMORANDUM NO. 1, GENERAL, PHASE I

Plate IV-1

requested by the landowners. In addition, all scarred areas will be topsoiled and seeded or sodded to restore a naturalistic appearance.

c. Wildlife Populations.

(1) Mammals. Upstream and downstream, there would be no significant disruption to existing populations. However, in the damsite area, there would be a major displacement of species which presently inhabit the proposed construction area and/or area to be inundated. Future developments in the project area would continue to reduce available habitats[g] and displace, or reduce in number, those species that are unable to adapt to an environment[g] where the effects of human populations are present.

(2) Amphibians and Reptiles. Upstream, there would be no change in populations' diversity and distribution. In the damsite area, construction activity would cause the loss or displacement of species. The inundation process would cause the displacement of most reptiles, but would not cause a significant disruption to amphibians. There would be a restabilization of species in suitable habitats along the periphery of the lake. Water releases or spills during flood stages could increase available habitat for certain species in the downstream area.

(3) Birds. Upstream, there should be no change in existing populations. In the damsite area, there will be a disruption or loss to those species that presently inhabit the terrestrial vegetation in the proposed construction or inundation area. There would be no change in the bird populations of the downstream area.

(4) Fishes. The proposed dam should cause no significant change, either beneficial or adverse, in the existing lacustrine fishery. The remains of the existing dam could possibly serve as a substrate for food sources, protection, and/or habitats for certain aquatic species. There should be no beneficial effects toward a downstream fishery except under flooding conditions.

d. Environmental Pollution.

(1) Air. Upstream and downstream, there should be no significant change in the air pollution. During construction in the damsite area, there would be an increase in noxious gases and particulate matter due to the activity of required machinery and transportation vehicles. Recreational vehicles will also contribute to the air pollution in the area.

(2) Noise. Upstream and downstream, there should be no significant increase in the noise pollution level. In the damsite area, there would be an increase in the noise pollution level during the construction phase of the project. Afterward, the noise pollution would result mainly from recreational and transportational vehicles and activities.

4.04 Historical or Archeological Elements. Although there would be no loss of archeological resources at the new damsite, three archeological sites have been found in the proposed borrow areas. An on-site investigation was conducted by archeologists from the Department of Anthropology, Southern Methodist University. They recommend additional testing in order to formulate a realistic mitigation plan (23). Salvage operations will be required for these

sites before the borrow areas are disturbed for material. Additionally, if any recognizable subsurface archeological remains are exposed during construction, the Texas State Historical Survey Committee will be notified as soon as possible so that salvage operations of the uncovered findings can be initiated.

Six state historical sites and several historic buildings exist in Brown County, but none occur in the immediate vicinity of the project. No historic sites of National, State, or local significance are known to exist in the project area.

4.05 Social, Cultural, and Economic Elements. A major beneficial social impact resulting from the proposed project would be the increase in social expectation and community cohesion.[9] The new dam will alleviate the present fears of dam failure, while the input of Federal funds into the community will promote community growth. The population of Brown County is expected to grow to an estimated 27,500 in 1980 and about 31,000 by the year 2000.

Unemployment could be reduced by utilizing local personnel in the construction activities. Although project completion would see the majority of the local labor returned to the labor market, they will have acquired skills and experience that will make them more desirable for other employers.

Construction of a new dam will not displace any families or businesses. Social patterns will be temporarily disrupted due to the relocation of one mile of county road and 3,500 feet of power and telephone lines. In addition, the project will cause some

social disruption resulting from a temporary increase in air, noise, and water pollution from construction activities.

Maintaining Lake Brownwood as a recreational attraction is undoubtedly a beneficial factor. The estimated recreational use of Lake Brownwood is about 400,000 recreation days annually; however, the project can provide opportunities for up to 945,455 recreation days annually. Without the lake to aid in satisfying the increasing demand for outdoor recreational opportunities, the environment of other existing projects could suffer from an overload of visitation, the quality of the recreational experience for each person would be reduced, and the recreational needs of this rural area would not be met.

The proposed project will cause some adverse economic impacts resulting from the loss in land use involved on acres required for project purposes, i.e., loss of 265 acres of pasture land and a portion of a pecan orchard (approximately 31 acres).

4.06 Effect Assessment. Section 122 of the River and Harbor Act of 1970, Public Law 91-611, specifies that all of the significant adverse and beneficial effects of civil works projects will be fully considered in preauthorization and postauthorization planning. Therefore, the proposed project modification, i.e., a new dam, and the alternatives to the proposed project are evaluated on their anticipated economic, social, and environmental effects in Section VI, Alternatives to the Proposed Action.

SECTION V - ANY ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

5.01 Stream Modification. Construction of the proposed project would result in the inundation and loss of approximately 1,000 feet of stream environment on Pecan Bayou.

5.02 Land Required for Project Purposes. The proposed project will require acquisition of lands totaling approximately 350 acres.

5.03 Transportation Disruption and Relocation. Approximately one mile of country road will have to be relocated in addition to the relocation of power and telephone lines. About 3,500 feet of line is needed to replace the 1,000 feet of existing communication and power lines.

5.04 Fish and Wildlife Resources. Construction in the new damsite area will cause some displacement and/or loss of mammals, amphibians, reptiles, birds, and fish. Wildlife displacement will also occur in the 265 acres of borrow areas.

5.05 Vegetative Resources. Some trees and natural vegetation will be removed from the 265 acres of borrow areas. Loss of trees and natural vegetation will also occur in the 83-acre damsite area.

5.06 Agricultural Resources. The proposed project would eliminate 31 acres of combination pecan orchard and farm lands valued at $40,000. The 265 acres of pastureland and cropland in the borrow areas would be a short term loss.

5.07 Air and Noise Pollution. Temporary adverse environmental effects will take place in the form of dust, noise, litter, and

inconvenience due to construction activity and the disruption of utilities and service during construction activities. Although these inconveniences are of relatively short duration in comparison to the life of the project, controls will be written into the construction specifications to minimize their effects.

5.08 Archeological Resources. A study conducted by archeologists from Southern Methodist University revealed three archeological sites located in the proposed borrow areas which would be destroyed if not salvaged prior to project construction.

5.09 Economic Resources. Land acquisition for the proposed project would result in the loss of approximately 83 acres of taxable land in the immediate dam area valued at about $1,250 per acre.

SECTION VI - ALTERNATIVES TO THE PROPOSED ACTION

6.01 General. The inadequacy and structural instability of the existing dam and spillway at Lake Brownwood could result in catastrophic consequences if they should fail under extreme flood conditions. Combined with the need to provide flood protection to suburban and other developed lands along Pecan Bayou is the need to supply water for municipal, agricultural, and industrial uses. Considering these present situations, any proposed plan should include the capabilities of satisfying these water supply and flood control needs. However, final decisions on proposed projects are made on more than pure economics and design criteria. In compliance with section 122 of Public Law 91-611, the proposed project and alternative plans are evaluated in the best public interest considering not only project purposes but also minimizing such adverse effects as air, noise, and water pollution. Other criteria included in the investigation are project related impacts on manmade and natural resources, esthetic values, community cohesion, availability or public facilities and services, employment, tax and property losses, and desirable community and regional growth. These social, economic, and environmental considerations are an integral part of the planning process and project formulation.

6.02 Evaluation of Alternatives.

a. General. One of three basic approaches could conceivably be taken with regard to the present situation at Lake Brownwood.

These three are: provide a dam which will meet standards of safety normally expected in embankments; remove the existing dam and thereby eliminate the threat of failure; and take no action.

b. No Action. The alternative of no action is a means of preserving the existing natural environment. This alternative would prevent the disruption or elimination of the natural terrain and associated plant and animal populations by construction activities or inundation. With no action, the present use of lands required for the proposed project would not be expected to change drastically; although, in the proposed borrow areas, the land use may vary between natural pasture and crop production. There would be no project related adverse impacts to archeological resources in the project area. In addition, there would be no required relocations of utility, communication, or transportation networks. However, this alternative would not reduce the threat of dam failure with subsequent catastrophic flooding and loss of water supply. Community cohesion would likely deteriorate with this alternative as the physical condition of the dam at Lake Brownwood becomes worse with time. Carefully planned flood warning systems to evacuate flood plains and contingency plans for obtaining emergency water should be considered if the no action plan is adopted.

c. Removal of Existing Dam. The potential hazard of catastrophic downstream flooding and sudden loss of water supply from failure of Lake Brownwood dam could be averted by simply removing the existing dam. Flood control lost by this action could be significantly regained by reservoirs immediately upstream on Jim Ned Creek and Pecan

Bayou. Downstream, flood control measures could be regained by including flood plain management practices, channels, levees, and fee and/or easement acquisition of flood prone lands. With the removal of the existing dam and loss of the lake, the cities of Brownwood, Early, Bangs, Santa Anna, and adjacent rural areas would be forced to seek other sources for their municipal, agricultural, and industrial water supply. The water supply that would be lost could be regained through upstream reservoirs or by importation of water from existing reservoirs in the vicinity. The nearest probable source of water importation would be Proctor Lake, which is about 35 miles northeast of Brownwood. The Brazos River Authority has the contract for 100 percent of the water supply storage in Proctor Lake, and a dependable yield of about 21.5 cfs. Currently, they are using only 20 percent of this dependable yield, so it is conceivable that the city of Brownwood could obtain up to 17.2 cfs from Lake Proctor. Nevertheless, this supply is not enough to meet the future needs of the area and would be only a temporary solution of the water supply problem. The valuable recreation resource at Lake Brownwood would be lost, and a number of recreation based commercial businesses would be depressed. Lower tax values for the related drop in land values would decrease the public revenue available in the area. The drained area could be reverted to farmland or pastureland, and the original stream could have some potential for recreational development.

d. Build a New Dam. This alternative would make the water

supplied from Lake Brownwood more dependable for municipal, industrial, and agricultural uses and would remove the fears that dam failure might occur. This structural plan would prevent the possible failure of the existing dam under extreme flood conditions and loss of lives downstream. This plan would protect the city of Brownwood, which would receive the most damage should the existing dam fail. In addition, this alternative would extend the useful life of Lake Brownwood and insure its continued operation as a means of reducing flood peaks and damages downstream, although the project does not include controlled flood storage space. This alternative would also extend the life of the lake as a recreational resource, with its extensive development for that purpose. About 83 acres of agricultural and naturally vegetated land would be required for the new damsite, and there would be a loss of taxable revenue from the agricultural production of the land at the dam area. There would be a similar loss of about 265 acres of land from the areas used for borrow. However, the local economy should not recognize these revenue losses because of the tremendous boost from the Federally funded project. The region should benefit from the use of local labor and the secondary benefits of the capital brought into the area. Community growth would be promoted by the input of Federal funds, while the existing lake would continue to be a focal point for leisure activities in the region.

6.03 Summary and Conclusion of Effect Assessment. The effects of each alternative plan were arranged under the major categories of

social, economic, and environmental elements, with each category receiving 100 points so they could be considered equally. Then the significant effects within the three categories were assigned weighting factors that reflected their relative importance to the project area and the region. These weights were based on the consensus of the professionals preparing the effect assessment and their overall knowledge of the base data on the project area. The alternatives were assigned a raw score either positive or negative for each effect considered according to the difference between the effect of the baseline, present condition, and that of the alternative being compared. A raw score within the range of positive five to negative five was assigned to each alternative for each effect (zero to positive five being beneficial effects, and zero to negative five reflecting adverse effects). Each raw score was multiplied by the appropriate weighting factor to give a weighted score. A summation of the weighted score for each alternative under the three major categories (social, economic, and environmental) is displayed in table VI-1. The alternative of building a new dam received the highest ranking among the alternatives evaluated and is, therefore, the most desirable from the social, economic, and environmental elements considered.

Table VI-1

Summary of Effects

	No Action	Build New Dam	Remove Existing Dam
Net social impact	+20	+145	-357
Net economic impact	0	+375	-315
Net environmental impact	-60	-205	-275
Total net impact	-40	+315	-947
Rank	2	1	3

SECTION VII - THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

7.01 Long term impacts concern the effects of a project which endure over a long period of time and may not be evident during the generation of individuals involved with the project development. In contrast, short-term refers to the effects of a project which are immediate or easily recognizable, although they may be in process many years past the construction period. Short-term benefits from an action may evolve into long-term detrimental effects. Many times man may bring about an action for his immediate benefit at the cost of detrimental effects to future generations. This is critical when man is dealing with a finite resource, which he may use up at the expense of his followers.

7.02 The modification of Lake Brownwood will pose both short-term and long-term effects, but the effects of not providing the improvements are much more significant. Long-term effects of the project include the requirement for a land area and a short stretch of the stream below the existing dam. Also, the construction activities will likely cause some disturbance in the form of air, noise, and water impacts during the construction period. These are the short-term effects which will be required to bring about long-term effects of reduced anxiety of the inhabitants in the downstream area, the continued supply of water for municipal, industrial, and agricultural purposes, and the maintenance of the lake as a recreational attraction. These are long-term effects which will last past the

generation which would be responsible for the development.

7.03 Perhaps more significant are the potential long-term effects if no action occurs. No immediate changes would occur without the modification of the existing dam, but at some time in the future the dam could fail and cause many long-term impacts. A major water supply source for the region would be lost as would the developed recreational attraction. Even more significant, but of shorter term duration would be the devastating effect of the resulting flooding in the downstream area. With this action, the communtities in the area would not have the water required for continued existence, and the area would have to develop another source in a short time or the population would likely decline sharply. This would be a significant impact to the region both economically and socially.

7.04 In terms of productivity, two facets are recognized; the productivity of natural resources for man's use and the productivity of the overall natural environment. With the availability of water supply, the majority of arable land is irrigated. This provides a much greater production from the natural resource than would dry land farming or pastureland use. In terms of the natural ecosystem, when water is introduced to an ecosystem in a somewhat dry climate, the effect is an increase in productivity and species diversity if other necessities of life such as shelter and food are provided. The greater the interlace between the cropland and habitat edge, the greater the wildlife productivity of the area. To place this

phenomenon into the situation in the Lake Brownwood area, if the irrigation is provided in an area with both natural pastureland and crop production, the net effect will be an increase in the productivity of the ecosystems. Just as crops provide intensive production for human use, they represent the high production of food to life in the area ecosystem. However, if land in the area is not cultivated, the productivity and diversity of the ecosystem is limited by the lack of shelter as well as diversification of foodstuffs. The net result is that without the irrigation produced by Lake Brownwood, the ecosystem production as well as the agricultural production for man's use would be lowered. With the proposed project total productivity would at least remain static within the area or would increase.

SECTION VIII - ANY IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

8.01 One irreversible commitment of resources involved is 83 acres of land needed for the site of the new dam. An additional 265 acres of pastureland will be needed for the borrow area, but in time this acreage would be reclaimed with proper management. The existing flora and fauna on land required for construction and for borrow area would be displaced.

8.02 Archeological resources other than those found could exist in the borrow and dam construction areas. If artifacts are discovered during construction activities, salvage operations or project modification will be undertaken. Investments in manpower and funds required for construction of the project are classified as irreversible and irretrievable.

SECTION IX - COORDINATION AND COMMENT AND RESPONSE

9.01 Summary of Project Coordination. Close coordination between Brown County Water Improvement District No. 1, the officials of Brownwood, Texas, the State of Texas, interested citizens and citizen groups, and representatives of the U.S. Army Corps of Engineers has been required throughout the Lake Brownwood Modification study. A public meeting will be held when project formulation is complete to discuss the results of the study on Lake Brownwood Modification, to present the details of the proposed project, the environmental considerations, and the alternatives studied, and to reiterate the public viewpoints concerning the proposed plan of improvement. Formal coordination of this draft environmental impact statement will be accomplished with appropriate Federal, State, regional, and local governmental agencies, citizen groups, conservation or environmental groups, and individuals known to have an interest in the proposed project (see paragraph 5, Comments Requested, page b). Comments received from these governmental and nongovernmental entities will be incorporated within the final environmental impact statement. Table IX-1 contains a chronological summary of this coordination.

9.02 Coordination of Land Use Plans. Included within this section are the written replies from Federal and State agencies in regard to possible conflicts of land use policies, plans, and controls for the affected area.

Table IX-1

Coordination-Lake Brownwood Modification

Date	Subject	Agency
1961-1963	Preauthorization investigations coordinated with other agencies.	SCS, BSFW, Bureau of Reclamation, Public Health Service, and interested State and local agencies and individuals.
2 July 1973	Notice of initiation of advance engineering and design studies. Comments requested.	Federal, State, and local governmental agencies, citizen organizations, and interested individuals.
22-24 August 1973	Meetings to gain basic information about project area and to obtain views and desires of local agencies and individuals.	Brown County Water Improvement District, Texas Parks and Wildlife Department, Brown-Mills Soil and Water Conservation District, SCS, City of Brownwood, Howard Payne College, commercial businesses at Lake Brownwood, and interested local individuals.
29 August 1973	Initiated coordination for historical aspects of the project.	Correspondence with Texas Historical Survey Committee.
September and October 1973	Archeological investigation.	Archeology Research Program, Department of Anthropology, Southern Methodist University.
20 September 1973	Initiated coordination on fish and wildlife aspects of the project.	Bureau of Sport Fisheries and Wildlife.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 648
Temple, Texas 76501

April 25, 1974

Mr. Gordon A. Walhood
Chief, Engineering Division
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Walhood:

We have your letter of April 16, 1974, pertaining to the Lake Brownwood Modification project. As we understand it,you are not changing the pool elevation of the present Brownwood lake. If our interpretation is correct,then there will be no effect on any project or plans for projects that the Soil Conservation Service would have. Of course, as you recognized, the construction of the new dam immediately below the present one will require some additional acreage. This, however, will not affect any program for which we are responsible.

We appreciate very much the opportunity to comment on this proposed project and will be looking forward to cooperating further, if the opportunity presents itself.

Sincerely,

For Edward E. Thomas
State Conservationist

REGION VI
Federal Building
819 Taylor Street
Fort Worth, Texas 76102

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION
FORT WORTH INSURING OFFICE
9A35 FEDERAL BUILDING, 819 TAYLOR STREET
FORT WORTH, TEXAS 76102

May 7, 1974

IN REPLY REFER TO:
6.9UV (Ashley)

Gordon A. Walhood, Chief
Engineering Division
Fort Worth District
Corps of Engineers
Post Office Box 17300
Fort Worth, Texas 76102

Dear Mr. Walhood:

This will acknowledge and answer your letter of April 16, 1974 informing us of the proposed Lake Brownwood Modification Project.

This office is not presently active in the area designated on your enclosed lake map and does not anticipate any activity in the foreseeable future.

Sincerely,

R. M. Hazlewood
Director

cc:
David W. Baker, Environmental Officer
Dallas, Texas

United States Department of the Interior
BUREAU OF RECLAMATION

SOUTHWEST REGION
AUSTIN DEVELOPMENT OFFICE
P.O. BOX 1946
AUSTIN, TEXAS 78767

IN REPLY
REFER TO:

April 18, 1974

Mr. Gordon A. Walhood
Chief, Engineering Division
Fort Worth District, Corps of Engineers
Post Office Box 17300
Fort Worth, Texas 76102

Dear Mr. Walhood:

Thank you for your letter of April 16, 1974 relative to your Lake Brownwood Modification project.

The Bureau of Reclamation has no current land use plans for the area affected by this project.

Sincerely

Norman G. Flaigg
Planning Officer

cc: Regional Director
Bureau of Reclamation
Amarillo, Texas

United States Department of the Interior

BUREAU OF OUTDOOR RECREATION
South Central Regional Office
Patio Plaza, 5000 Marble N.E., Room 211
Albuquerque, New Mexico 87110

IN REPLY REFER TO:
Texas

MAY 8 1974

Mr. Gordon A. Walhood
Chief, Engineering Division
Ft. Worth District
Corps of Engineers
P. O. Box 17300
Ft. Worth, Texas 76102

Dear Mr. Walhood:

This is in reply to your April 16, 1974, letter requesting information for inclusion in the environmental impact statement on the Lake Brownwood Modification project.

We understand that the proposed modification project will not alter the normal operating water levels of the existing lake. The EIS should, however, discuss the possibility of higher waters occurring during flood periods due to the greater water retention capacity of the proposed dam. Any impacts upon recreation at Lake Brownwood State Park and other recreation areas resulting from these higher waters should be discussed.

Impacts upon recreation and aesthetic values at the site of the proposed dam should also be discussed. This may include loss of free-flowing stream values and other recreation areas.

We appreciate the opportunity to comment at this stage prior to formulation of the draft EIS.

Sincerely yours,

Acting Rolland B. Handley
Regional Director

ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1600 PATTERSON, SUITE 1100
DALLAS, TEXAS 75201

June 13, 1974

OFFICE OF THE
REGIONAL ADMINISTRATOR

Mr. Gordon A. Walhood
Chief, Engineering Division
Fort Worth District
Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Walhood:

This is in response to your letter requesting information on any land use plans we might have in connection with the preparation of an Environmental Impact Statement on Lake Brownwood Modification Project in the Pecan Bayou watershed. We apologize for the delay in responding to your letter.

Our agency has no specific land use plans at this time. However, we should inform you of the waste load allocation for Pecan Bayou which has been developed by the Texas Water Quality Board. This allocation indicates that because of the intermittent nature of Pecan Bayou below Lake Brownwood, periodic violations of the dissolved oxygen standard will occur. The dissolved oxygen level problem appears to be related to the discharge of treated municipal wastewater. However, measures to control this violation by the upgrading of municipal wastewater treatment facilities in the area will be implemented in the near future. Additional information concerning the wastewater allocation for Pecan Bayou can be obtained from the Texas Water Quality Board.

If you should need further assistance, please let us know.

Sincerely yours,

/s/ Arthur W. Busch
Regional Administrator

.PH BRISCOE
OVERNOR

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION

JAMES M. ROSE
DIRECTOR

May 2, 1974

Mr. Gordon A. Walhood
Ft. Worth District, Corps of Engineers
P. O. Box 17300
Ft. Worth, Texas 76102

Dear Mr. Walhood:

We have reviewed the subject of the Lake Brownwood Modification project with pertinent State Agencies. We find no land use plans, controls or projects here at the State level with which the modification might conflict.

Precedent established during this administration is that land use plans, controls and decisions should be made at the lowest level of government consistent with the impact of these decisions. We support the decisions of the people of Brownwood and Brown County in this matter. My staff has contacted Mr. Bobbie T. Gallegher of the West Central Texas Council of Governments and was informed that he is also addressing this question for you.

If I can be of further assistance, please contact me.

Sincerely,

James M. Rose
Director

JMR:ash

P. O. BOX 12428, CAPITOL STATION, AUSTIN, TEXAS 78711
Phone 512/475-2427 Offices Located in Sam Houston State Office Building

WCT COG west central texas council of governments

REGIONAL PLANNING
TECHNICAL ASSISTANCE
COMMUNITY SERVICES

April 23, 1974

Mr. Gordon A. Walhood, Chief
Engineering Division
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Sir:

This letter is to inform you that the staff of the West Central Texas Council of Governments has reviewed your outline for the Lake Brownwood Modification Project and concurs with the proposed development.

Land use in the vicinity of Lake Brownwood is considered to be primarily recreation/open space oriented with a gradual build up of summer homes and residences. The proposed Lake Brownwood Modification Project appears to be an improvement to the existing conditions and has no conflicting elements with existing land use or the projected trend of development.

If we can be of further assistance, please contact us at your convenience.

Sincerely,

Randy Randolph

Randy Randolph
Director of Regional Planning
West Central Texas Council of Governments

RR:dlh

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GLOSSARY

ACRE-FOOT. The volume of water contained in one surface acre one foot deep.

ALLUVIUM. Sediments, usually fine materials, deposited on land by running water.

AQUIFER. A water bearing stratum of permeable rock, sand, or gravel.

BROADCRESTED WEIR. A constriction placed in a stream or channel to force flow through a notch for measurement. The weir is broadcrested if the flow occurs over a flat, level surface rather than touching only the upstream edge of the crest.

BORROW AREA. The land area from which materials such as soil or rock to be used in the construction of some structure are excavated.

CONGLOMERATE BEDS. Deposits of rock made up of worn and rounded pebbles of other rocks cemented together. A consolidated gravel.

CHANNEL-FILL. The use of materials available, i.e., soil, rock, etc. to fill a definite bed with banks which once served to confine the flow of water.

COMMUNITY COHESION. A group of people who live and interact with unifying force due to one or more characteristics providing a commonality such as race, education, income, ethnicity, religion, language, social class, and/or mutual economic and social benefit.

CONSERVATION (WATER SUPPLY) STORAGE. Space in a lake for storage of water for such purposes as municipal and industrial water supply, irrigation, electric power production, and recreation.

DRAWDOWN. The magnitude of change in surface elevation of a body of water as a result of the withdrawal of water therefrom.

DRAINAGE BASIN. The area from which water in a water body or at a given point or location on a stream originates; a watershed.

ECOSYSTEM. The dynamic system formed by the interactions and reactions of all the members of a community with the physical and chemical features of the environment.

ENVIRONMENT. The sum total of all the external conditions which may influence organisms.

FLOOD OF RECORD. A maximum flood recorded in a period during which records have been maintained for a drainage area.

FRONTAL STORM. Precipitation caused when a warm, moist air mass is lifted above a more dense, cool air mass. The warm air is cooled, the moisture condenses, and precipitation results.

GATED CONDUIT. An artificial or natural duct with controllable gates attached which can be used to close off the flow of water through the duct.

GEOMORPHOLOGY. The investigation of the history of geologic changes through the interpretation of topographic forms.

HABITAT. The sum total of environmental conditions of a specific place that is occupied by an organism, a population, or a community.

IMPERVIOUS COMPACTED SOIL CORE. The central section of a dam along its axis which is filled with a material through which water cannot pass.

INVERT OF THE OUTLET WORKS. The elevation of the bottom of the outlet works intake.

INTERBEDS. Material deposited between the stratified bed deposits; the well stratified materials in a marked divisional plane.

LITHOLOGY. The study of the physical character of a rock.

LITHIC DEBRIS. Scattered rock fragments from rock which has been broken up and carried to various points by natural forces.

PERMEABILITY. The property of porous material which permits movement of water through it.

PHYSIOGRAPHIC TRANSITIONS. The varying intermediate materials which form a continuum between landforms whose evaluation is similar.

RECREATION DAY. One of the standard recreational units of use, defined as a visit by one individual to a recreation site or area for recreational purposes during all or any reasonable portion of a 24-hour period.

RIVER MILE. A unit of measure starting from the mouth of a water-course upstream along the deepest part of the channel of the main course to its designated point of origin.

RIPARIAN. Related to or associated with the land which borders a stream or river.

SEDIMENTATION. The process of deposition by gravity of suspended matter carried by water, sewage, or other liquids. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material.

STRIKE. The course or horizontal angle of the outcrop of an inclined stratified deposit on a level surface.

STRATA. Sheet-like masses of sedimentary rock or earth deposits of one kind lying between deposited beds of other kinds.

STRATIGRAPHY. That section of geology that deals with the origin, composition, distribution, and succession of strata.

SHRINK-SWELL. The decrease or increase in dimension suffered by a soil mass when the moisture content is reduced or increased from an amount equal to the percentage of a starting base point in time or from controlled conditions.

STREAM COMMUNITY. All of the plants and animals associated with a stream and their complex interrelationships.

SECOND-FEET. An abbreviated expression for cubic feet per second.

SPILLWAY DESIGN FLOOD. The magnitude of flood used in determining the hydraulic requirements of a dam and spillway.

TERRACE DEPOSIT. Relative flat benches formed by the deposition of various sands, silts, and other materials deposited by a stream which once flowed over the area.

WATERSHED. The defined area from which water drains and flows into a particular watercourse or body of water.

WATER SUPPLY STORAGE. See conservation storage.

References: Numbers 10, 14, and 27 in Bibliography.

Appendix A

BIOLOGICAL INVENTORY - TERRESTRIAL VEGETATION

Species	Range sites at existing damsite and proposed project area*: Loamy bottomland site Abundance (%)	Loamy bottomland site Habitat or food	Low stony hills Abundance (%)	Low stony hills Habitat or food	Rocky hills Abundance (%)	Rocky hills Habitat or food	Shallow clay site Abundance (%)	Shallow clay site Habitat or food	Range in United States#	Project Impact
GRASSES:	(80%)		(80%)		(85%)		(85%)			
Indiangrass *Sorghastrum nutans*	20	C,S			5	C,G			Quebec & Maine to Manitoba & North Dakota, south to Florida & Arizona	Moderate
Big bluestem *Andropogon gerardi*	10	C,S	5	C,S					Quebec & Maine to Montana, south to Florida, Wyoming, Utah, & Arizona	Moderate
Switchgrass *Panicum virgatum*	10	C,S,							Maine to North Dakota & Wyoming, south to Florida, Nevada, & Arizona	Minimal
Canada wildrye *Elymus canadensis*	5	C,D	5	C	5	C			Alaska, south to North Carolina, Missouri, Texas, Arizona, and northern California	Moderate
Little bluestem *Andropogon scoparius*	10	C,S	15	C,S,G	15	C,G	(Trace)	C,D,T	Texas to Arizona	Moderate
Texas wintergrass *Stipa leucotricha*	5	S	5	C,S,G	5	C	10	C,D,T	Oklahoma and Texas to Central Mexico	Moderate
Sideoats grama *Bouteloua curtipendula*	5-10	C,S,T,Q,	15	C,S,G			20	C	Montana, south to Virginia, Alabama, Texas, Arizona & southern California	Moderate
Vine mesquite *Panicum obtusum*	5	C,Q	5	S			10		Western Missouri to Colorado, south to Arkansas, Texas, Utah, & Arizona	Moderate
Cane bluestem *Andropogon barbinodis*			5	C,S	5	C	5	C	Oklahoma & Texas to California & Arizona	Moderate
Silver bluestem *Andropogon saccharoides*			5	C,Q,S					Missouri to Colorado, & Alabama to Arizona	Minimal
Buffalograss *Buchloe dactyloides*			(Trace)	C,S G					Minnesota & Montana, south to northwestern Iowa, Texas, west Louisiana, and Arizona	Insignificant
Curly mesquite *Hilaria belangeri*			5	C,S,G	5		20	C	Texas to Arizona and northern Mexico	Moderate

APPENDIX - A (continued)

Species	Range sites at existing damsite and proposed project area: Loamy bottomland site Abundance (%)	Loamy bottomland site Habitat or food	Low stony hills Abundance (%)	Low stony hills Habitat or food	Rocky hills Abundance (%)	Rocky hills Habitat or food	Shallow clay site Abundance (%)	Shallow clay site Habitat or food	Range in United States	Project Impact
Hairy grama *Bouteloua hirsuta*			(Trace)		10				Wisconsin & North Dakota to Texas, Colorado, Arizona, & California; peninsular Florida	Minimal
Threeawns *Tridens* sp.			5	S			(Trace)		Texas to Nevada and southern California to southern Mexico	Minimal
Red grama *Bouteloua trifida*			(Trace)		(Trace)				Texas to Nevada & Arizona; northern Mexico	Insignificant
Texas cupgrass *Eriochloa sericea*			(Trace)	C	10	C	5	C	Texas and Oklahoma	Moderate
Rough tridens *Tridens muticus*					5	C			Texas to southeastern California, north to Nevada & Utah	Minimal
Cottontop *Trichachne californica*							10	C	Texas & Oklahoma to Colorado, Arizona, and Mexico	Moderate
WOODY:	(15%)		(10%)		(5%)		(5%)			
Pecan *Carya illinoeonsis*	5	T							Texas, Oklahoma, Arkansas, & Louisiana; east to Alabama; north to Kansas, Iowa, Indiana, & Tennessee	Minimal
Elm *Ulmus* sp.	5	C,D,T			(Trace)	D,G,Q	(Trace)	D,Q,T	Texas, Oklahoma, Arkansas, & rare, eastward & northward	Minimal
Oak *Quercus* sp.	(Trace)	T,Q	10	D,G,Q					Texas, Oklahoma, & Arkansas eastward through Louisiana and northward	Moderate
Elbowbush *Forestiera pubescens*	(Trace)	D			(Trace)	D,G			New Mexico, Texas, & Oklahoma eastward to Florida	Insignificant
Hackberry *Celtis* sp.	(Trace)	C,S,D,Q,T			(Trace)	D,G,Q,T	(Trace)	D,Q,T	Texas, Arkansas, Oklahoma, Louisiana, eastward & northward	Insignificant
Greenbriar *Smilax* sp.	(Trace)	T,Q							Texas, Arkansas, & Louisiana: eastward to Florida	Insignificant

APPENDIX - A (continued)

Species	Range sites at existing damsite and proposed project area: Loamy bottomland site Abundance (%)	Loamy bottomland site Habitat or food	Low stony hills Abundance (%)	Low stony hills Habitat or food	Rocky hills Abundance (%)	Rocky hills Habitat or food	Shallow clay site Abundance (%)	Shallow clay site Habitat or food	Range in United States	Project Impact
Skunkbush Rhus aromatica	(Trace)	D,T			(Trace)	D,G,Q,T			Eastern Texas, Oklahoma, Arkansas, & Louisiana; eastward to Florida	Insignificant
Grapevine Vitis sp.	(Trace)								Oklahoma, Arkansas, Texas, & Louisiana eastward to Florida	Insignificant
Catclaw Acacia greggii			(Trace)	Q,T					Texas, New Mexico, Arizona, & Colorado, north to Utah and Nevada, west to California	Insignificant
Lotebush Condalia sp.			(Trace)	Q,T			(Trace)	D,Q,T	Texas, Arizona, and New Mexico	Insignificant
Yucca Yucca sp.			(Trace)						Texas & northwestern Louisiana to central & eastern Oklahoma & western Arkansas	Insignificant
Prickly pear Opuntia macrorhiza			(Trace)	T,Q					Texas, northward to Missouri & Kansas	Insignificant
Sumac Rhus sp.			(Trace)		(Trace)				Texas, New Mexico, Oklahoma, Arkansas,Louisiana, & Arizona	Insignificant
Bumelia Bumelia lanuginosa			(Trace)	D,Q					Texas, Oklahoma, Arkansas, Louisiana, east to Florida, north to Kansas & Missouri	Insignificant
Tasajillo Opuntia leptocaulis					(Trace)	T			Texas, west through New Mexico to California	Insignificant
Ephedra Ephedra antisyphilitica					(Trace)		5		Texas, southwestern Oklahoma, & Mexico	Insignificant

Species	Range sites at existing damsite and proposed project area: Loamy bottomland site Abundance (%)	Loamy bottomland site Habitat or food	Low stony hills Abundance (%)	Low stony hills Habitat or food	Rocky hills Abundance (%)	Rocky hills Habitat or food	Shallow clay site Abundance (%)	Shallow clay site Habitat or food	Range in United States	Project Impact
FORBS:	(5%)		(10%)		(10%)		(10%)			
Englemann Daisy *Englemannia pinatiffida*	(Trace)	C,S,D	3	C,S,G,D	(Trace)	D,G			Western Missouri, Kansas, & Louisiana to Colorado & Arizona	Insignificant
Maximillian sunflower *Helianthus maximiliani*	(Trace)	C,S,D,T							Manitoba & Saskatchewan south to Missouri & Texas	Insignificant
Ironweed *Vernonia baldwinii*	(Trace)								Iowa and Missouri west to Texas, Nebraska & Kansas	Insignificant
Trailing Wild Bean *Strophostyles helvola*	(Trace)	D,Q							Quebec south to Florida; west to South Dakota, Kansas & Texas	Insignificant
Bush sunflower *Helianthus annuas*	(Trace)	C,S,D,T	3	C,S,G,D,Q					Maine to Minnesota south to South Carolina, Missouri, & Texas	Insignificant
Orange Zexmenia			3	D						Insignificant
Bundleflower *Desmanthus* sp.					(Trace)	D,G,Q,T			Missouri & Kansas to Texas & Arizona	Insignificant
Sensitive briar *Schrankia uncinata*					(Trace)	D,G,T	3	C,D,Q,T	South Dakota, Illinois, & Virginia southward to Florida & Texas	Insignificant
Daleas *Dalea* sp.					(Trace)	G	3	C,D,T		Insignificant
Gayfeather *Liatris elegans*			(Trace)	D,C	(Trace)	D	3		Texas & New Mexico	Insignificant
Trailing ratany *Krameria lanceolata*					(Trace)	D,G				Insignificant

Key: C, cattle; S, sheep; G, goats; D, deer; Q, quail and dove; T, turkey
*Reference number 25 in the bibliography
#Reference numbers 1, 12, and 31 in the bibliography

AD-A096 184 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2
LAKE BROWNWOOD MODIFICATION PECAN BAYOU WATERSHED, COLORADO RIV--ETC(U)
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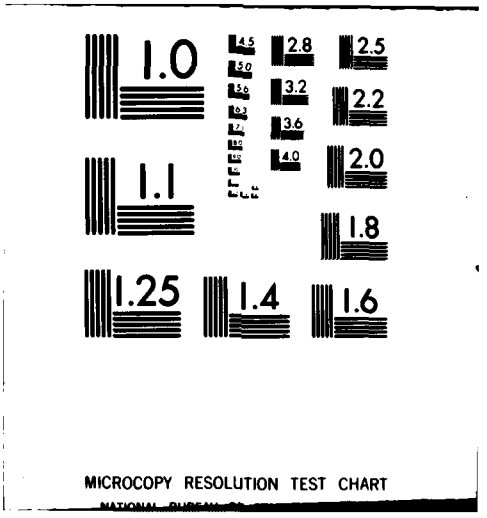
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APPENDIX - B

BIOLOGICAL INVENTORY - MAMMALS

Species	Habitat*	Range in Region or State*	Abundance in Region*	Range in the United States#	Project Impact
Opossum Didelphis marsupialis	Deciduous woodlands, prairies, marshes and farmlands	Statewide except for far west Texas	Common	Eastern half of U.S.	Minimal
Eastern mole Scalopus aquaticus	Subterranean (damp and boggy)	Eastern half of Texas	Uncommon	Texas north to Nebraska, and east to coast	None
Cave bat Myotis velifer	Caves and old or abandoned buildings	From Williamson County west through the State	Uncommon	Kansas through Texas to New Mexico	None
Big brown bat Eptesicus fuscus	Forests, attics, buildings, and caves	North of Lampasas County through State	Uncommon	Generally throughout U.S.	None
Hoary bat Lasiurus cinereus	Wooded areas; migratory	West of Williamson County through State	Uncommon	Throughout, except south Florida	None
Lump-nosed bat Plecotus townsendii	Rocky caves, crevices and mine tunnels	West Texas and panhandle	Uncommon	Southeastern states	None
Red bat Lasiurus borealis	Roost in the open in trees	Statewide	Uncommon	Central & eastern states; far west coastal states	None
Guano bat Tadarida mexicana	Caves, tunnels, buildings, and hollow trees	Statewide, except east Texas	Uncommon	Southern states	None
Raccoon Procyon lotor	Broadleaf woodlands and mixed pine forests along streams or lakes	Statewide	Common	Nationwide, except parts of Montana, Wyoming, & Colorado	Insignificant
Ringtail Bassariscus astutus	Rock piles, stone fences, canyon walls, and talus slopes	Central & west Texas, panhandle	Common	Texas, west to California southern Colorado & Utah	Insignificant
Mink Mustela vison	Smaller streams, lakes, ponds, & waterways	Central and east Texas	Uncommon	Nationwide, except west Texas, New Mexico, Arizona, southern California, & Nevada	Insignificant
Spotted skunk Spilogale putorius	Wooded areas, tall-grass prairies, rocky canyons, & outcrops	Statewide, except southern portion of panhandle	Uncommon	Nationwide, except far north & New England	Insignificant
Hog-nosed skunk Conepatus mesoleucus	Partly timbered or brushy foothills; rocky areas	West, south central, & south east Texas	Very few	Southern Texas, New Mexico, & Nevada	Insignificant

APPENDIX - B (continued)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Striped skunk Mephitis mephitis	Woody or brushy areas and their associated farmlands	Statewide	Very common	Nationwide	Insignificant
Badger Taxidea taxus	Prairie and desert areas with ground squirrels and prairie dogs	Panhandle and west central and south Texas	Common	Texas north to Canada and west to California and Washington	Insignificant
Gray fox Urocyon cinereoargenteus	Short-grass plains and mixed hardwood forests	Statewide, except panhandle	Common	Southern states and New England	Insignificant
Coyote Canis latrans	Ranges from desert scrub through grassland into timber section	Statewide	Very Common	Central and western U.S.	Insignificant
Cougar Felis concolor	Rocky canyons, escarpments, rimrocks, or dense brush	South, south central, and west Texas	Very few	Texas, north to central Montana and west to coast	Insignificant
Bobcat Lynx rufus	Rocky canyons and outcrops, or heavy thickets	Statewide	Uncommon	Texas to North Dakota & west to coast, plus southern states	Insignificant
Mexican ground squirrel Citellus mexicanus	Brushy or grassy areas	South, south central, and west Texas and south panhandle	Uncommon	Texas and southeast corner of New Mexico	Insignificant
Rock squirrel Citellus variegatus	Rocky cliffs, walls, slopes, piles, and highway fills	Central and west Texas (Big Bend)	Uncommon	Texas, New Mexico, Arizona, southern Nevada, Utah, and Colorado	Insignificant
Plains pocket mouse Perognathus flavescens	Sandy soils with sparse vegetation	High plains and panhandle	Uncommon	Central U.S., from Texas to North Dakota	Insignificant
Merriam pocket mouse Perognathus merriami	Sandy, stony, or gravelly soils with sparse vegetation	West of San Patricio and Montague Counties	Uncommon	Texas and southeastern New Mexico	Insignificant
Hispid pocket mouse Perognathus hispidus	Sandy soil with herbaceous vegetation	Statewide	Common	Texas, New Mexico, north to North Dakota	Insignificant
Gray harvest mouse Reithrodontomys montanus	Climax, or near climax, well-drained grassland	Central, north central, and west Texas and panhandle	Common	Texas, New Mexico, north to South Dakota	Insignificant
Deer mouse Peromyscus maniculatus	Mixed forests to grasslands, to open sparsely vegetated deserts	West of Grayson and Calhoun Counties	Common	Nationwide, except southeastern states	Insignificant

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
White-footed mouse Peromyscus leucopus	Woodlands and bottomlands of creeks and rivers	Statewide	Very Common	Central and eastern U.S.	Insignificant
Brush mouse Peromyscus boylii	Brush and trees; stream banks, rock walls, and cabins	Central, north central, west Texas and panhandle	Uncommon	Texas and Oklahoma west to California	Insignificant
Encinal mouse Peromyscus pectoralis	Rocky cliffs, slopes, walls, and bluffs	West Texas and Big Bend east to central Texas & up through high plains	Uncommon	Texas, and a very small portion of southeastern New Mexico	Insignificant
Hispid cotton rat Sigmodon hispidus	Tall grass areas of old fields and natural prairies	Statewide	Common	South Arizona & New Mexico, Texas, Oklahoma, & Kansas east to the coast	Insignificant
Gray wood rat Neotoma micropus	Brushlands of semi-arid regions; cacti, mesquite, or thornbush	South, west, high plains, and panhandle	Common	Texas, New Mexico, western Oklahoma, and southern Colorado and Kansas	Insignificant
White-throated wood rat Neotoma albigula	Brushlands of deserts; prickly pear, cactus, mesquite and sotol	Central, west, and high plains (Big Bend)	Uncommon	Texas, New Mexico, and Arizona	Insignificant
House mouse Mus musculus	Houses, stores, outbuildings, and other structures	Statewide	Very Common	Nationwide	Insignificant
Roof rat Rattus rattus	Stores, warehouses, houses, gins, and barns	Most of State	Common	Nationwide	Insignificant
Norway rat Rattus norvegicus	Buildings, stores, garbage dumps, and uncultivated areas	Widespread in State	Very Common	Nationwide	Insignificant
Nutria Myocaster coypus	Swamps, marshes, along the shores of rivers and lakes	Statewide, except west Texas and panhandle	Common	Louisiana, Oregon, and widespread over U.S.	Insignificant
California jackrabbit Lepus californicus	Hot, dry desert scrubland, tall grasses and shrubs	Statewide, except for east Texas	Common	Texas to Kansas and west to the coast	Insignificant
Eastern cottontail Sylvilagus floridanus	Brushlands, pastures, fields, and streamsides	Statewide, except west Texas and Big Bend	Common	Texas to North Dakota and east to coast	Insignificant
Audubon cottontail Sylvilagus auduboni	Grasslands, brush, and cactus desert	Kennedy to Wichita Counties through west Texas	Common	Texas north to Montana and west to southern California	Insignificant
White-tailed deer Odocoileus virginianus	Suitable brushy or wooded areas throughout State	Statewide	Common	Eastern, Rocky Mountain, and Pacific Coast states	Insignificant

*Reference number 4 in the bibliography

#Reference number 7 in the bibliography

APPENDIX - C

BIOLOGICAL INVENTORY - AMPHIBIANS AND REPTILES

Species	Habitat*	Range in Region or State#	Abundance in Region#	Range in the United States*	Project Impact
Eastern tiger salamander *Ambystoma tigrinum*	Underground in burrows, crevices, or decayed logs and stumps	Statewide	Uncommon	Long Island to northern Florida; Ohio to Minnesota and south to Gulf	Minimal
Couch's spadefoot *Scaphiopus coughi*	Short-grass plains, mesquite savannas, arid, and semi-arid regions	North central, central, and south Texas west through the State	Common	Central Texas and adjacent Oklahoma, west to Arizona & south into Mexico	Minimal
Cricket frog *Acris crepitans*	Lowlands, bogs, ponds, and river-bottom swamps	Statewide	Common	Michigan and Ohio to eastern Colorado and northeast Mexico	Minimal
Gray treefrog *Hyla versicolor*	Small trees and shrubs near or standing in shallow bodies of water	South central, central and north central Texas, and eastward through the State	Uncommon	Canada to northern Florida; west to eastern North Dakota and central Texas	Minimal
Spotted chorus frog *Pseudacris clarki*	Grassland prairies	Statewide, except for east and west Texas	Common	Central Kansas to south Texas	Minimal
Strecker's chorus frog *Pseudacris streckeri*	Woods, rocky ravines, streams, lagoons, sand prairies, and fields	South central, north central, and east Texas	Common	Central Oklahoma south Gulf coast. Arkansas, Missouri and Illinois	Minimal
Eastern greentoad *Bufo debilis*	Arid regions, under rocks	Statewide, except for east Texas	Common	Southern Kansas to northeast Mexico	Minimal
Red-spotted toad *Bufo punctatus*	Rough, rocky regions and open grasslands	Statewide, except for east Texas	Common	Southwestern Kansas and central Texas to south-eastern California into Mexico	Minimal
Texas toad *Bufo speciosus*	Grasslands, culivated areas, and mesquite-savannas	Statewide, except for east Texas	Very Common	Extreme southwest Kansas to New Mexico	Minimal
Gulf Coast toad *Bufo valliceps*	Coastal prairies, barrier beaches, dumps, and storm sewers	South, south central, and south-east Texas	Common	South Louisiana, east & south Texas & south to Costa Rica; south Arkansas	Minimal
Woodhouse's toad *Bufo woodhousei*	Sandy areas around shores of lakes or in river valleys	Statewide, except far south Texas	Common	New England to Gulf Coast & west to Michigan, north-east Oklahoma & eastern Louisiana	Minimal

APPENDIX - C (continued)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Bullfrog Rana catesbeiana	Lakes, bogs, sluggish portions of streams, cattle tanks	Statewide	Common	From east coast west to Wisconsin & Nebraska, south through the central plains	Minimal
Leopard frog Rana pipiens	Arid conditions and around watercourses and cattle tanks	Statewide	Very Common	South Nebraska to Central America	Minimal
Great plains narrow-mouthed toad Gastrophryne olivacea	Grasslands, marshy sloughs, and rocky, open-wooded slopes	Statewide, except far west Texas and panhandle	Very Common	Southeast Nebraska and west Missouri to northern Mexico	Minimal
Snapping turtle Chelydra serpentina	Any permanent body of fresh water, large or small	Statewide, except far west Texas and the valley	Uncommon	South Canada to Gulf; Atlantic Ocean to Rocky Mountains	Minimal
Yellow mud turtle Kinosternon flavescens	Bodies of water, usually with a muddy bottom	Statewide, except for east Texas	Common	Illinois to northern Mexico	Minimal
Slider (Texas) Pseudemys concinna	Rivers, ditches, and cattle tanks	Central Texas	Common	Central and south Texas and adjacent Mexico	Minimal
Red-eared turtle Pseudemys scripta	Quiet, muddy water with lots of vegetation	Statewide	Common	Ohio and Iowa to New Mexico	Minimal
Texas map turtle Graptemys versa	Larger bodies of water, lakes, and rivers	Central Texas	Uncommon	Colorado River System, Texas	Minimal
Ornate box turtle Terrapene ornata	Plains and prairies, in sandy, arid conditions	Statewide	Common	Indiana to southeast Wyoming, through Texas	Minimal
Smooth softshell Trionyx muticus	Rivers and streams, sometimes in lakes	North central Texas	Uncommon	Western Pennsylvania to extreme west Florida; west to Minnesota, South Dakota, and Texas	Minimal
Texas softshell Trionyx Spinifer	Permanent streams	Statewide	Common	West Louisiana to Colorado River (of California)	Minimal
Greater earless lizard Cophosaurus texanus	Rocky streambeds, sandstone outcrops, rocky desert flats	South to panahndle and west Texas	Very Common	Central Texas to Arizona and northern Mexico	Minimal
Collared lizard Crotaphytus collaris	Hilly, rocky, arid, or semi-arid regions	Central, north central, west Texas, and panhandle	Very Common	Central Missouri to eastern New Mexico; south to Durango	Minimal

APPENDIX - C (*continued*)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Spot-tailed earless lizard *Holbrookia lacerata*	Arid, dark-soil flats, mesquite, prickly pear and associated species	South and central Texas	Uncommon	Central and south Texas and adjacent Mexico	Minimal
Lesser earless lizard *Holbrookia maculata*	Sandy areas, open or with scant vegetation	Central, north central, west Texas, and panhandle	Uncommon	South Dakota to Texas, Arizona & northeastern Mexico	Minimal
Texas horned lizard *Phrynosoma cornutum*	Dry, flat, open terrain with sparse plant cover	Statewide	Very Common	Kansas to southeastern Arizona & northern Mexico	Minimal
Texas spiny lizard *Sceloporus olivaceus*	In trees - mesquite, live oak, cottonwood, cedar, etc.	South, central, north central, and east Texas	Very Common	Extreme southern Oklahoma to northeast Mexico; southern New Mexico	Minimal
Crevice spiny lizard *Sceloporus pointsetti*	Boulders and rocky outcrops	Central and west Texas	Uncommon	Central Texas to southwest New Mexico; south to Durango	Minimal
Prairie lizard *Sceloporus undulatus*	Sand dunes, brushy flatlands, cliffs, and bases of buttes	Statewide	Very Common	South Dakota to northern Mexico; west to southeast Arizona	Minimal
Tree lizard (Eastern) *Urosaurus ornatus*	In trees or on rocks	Central through west Texas	Uncommon	Central Texas to Rio Grande Valley	Minimal
Short-lined skink *Eumeces brevilineatus*	Rocky or sandy areas in rough, hilly country or plains where water is present	South, central, north central Texas, and Big Bend	Common	Central and southwes Texas and northeastern Mexico	Minimal
Great plains skink *Eumeces obsoletus*	Rough country, grassy or wooded hillsides, open plains, & sandy areas	Statewide, except east Texas	Common	Nebraska to Arizona and northern Mexico	Minimal
Northern prairie skink *Eumeces septentrionalis*	Shallow burrows, and excavations in soft soils	North and south central, through east Texas	Uncommon	Extreme south Manitoba to Wisconsin and Kansas	Minimal
Ground skink *Lygosoma laterale*	Woodland floor among leaves, decaying wood and detritus	South, central, north central and east Texas	Uncommon	Southern New Jersey to Florida Keys; west to east Kansas & central Texas	Minimal
Spotted whiptail *Cnemidophorus gularis*	Open, arid and semi-arid prairie	Statewide, except east Texas and panhandle	Common	Southern Oklahoma through most of Texas	Minimal
Six-lined racerunner *Cnemidophorus sexlineatus*	Open woodlands and fields	East Texas	Common	Maryland south through Florida, west to east Texas, north to Minnesota	Minimal

APPENDIX - C (continued)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Texas alligator lizard *Gerrhonotus liocephalus*	Bushes on rocky slopes	Central Texas, Edwards Plateau, and Big Bend	Uncommon	Portions of Texas	Minimal
Slender glass lizard *Ophisaurus attenuatus*	Subterranean	East Texas south to Rio Grande	Uncommon	North Caolina south to Florida; west of Mississippi, south to Texas and Mexico	Minimal
Texas blind snake *Leptotyphlops dulcis*	Moderately sandy,semi-arid prairies	Panhandle to central Texas	Uncommon	Panhandle and Red River sections of Oklahoma to central Texas & Hildago, Mexico	Minimal
Texas glossy snake *Arizona elegans*	Sandy to very sandy areas	Statewide, except panhandle and east Texas	Uncommon	West Texas (except panhandle) to eastern New Mexico & south to Mexico	Minimal
Black racer *Coluber constrictor*	Logs, woodlands, through east Texas	Eastern Texas	Common	North Carolina to east Texas & southeast Oklahoma, north to southern Indiana, & south through Florida	Minimal
Northern ringneck snake *Diadophis punctatus*	Under rocks and logs in wooded areas, moist woodlands	Devil's and Pecos Rivers northeast to southeastern panhandle	Common	From Atlantic to Pacific	Minimal
Corn snake *Elaphe guttata*	Primarily cornfields, varied habitat	Statewide	Common	Southern New Jersey to Florida, west to Texas	Minimal
Texas rat snake *Elaphe obsoleta*	Varied habitats throughout the State	Central and east Texas	Common	Western Louisiana, east and central Texas	Minimal
Western hognose snake *Heterodon nasicus*	Dry western prairies, sandy regions	Statewide	Uncommon	West from Illinois to Arizona, south to Mexico	Minimal
Eastern hognose snake *Heterodon platyrhinos*	Dry, sandy areas	West Texas	Common	Eastern & central U.S.	Minimal
Night snake *Hypsiglena torquata*	Under stones or logs in arid or semi-arid regions	Central Texas	Common	New Mexico to southern Kansas, western Oklahoma to central Texas	Minimal
Kingsnake *Lampropeltis getulus*	Sandy regions	Central Texas	Uncommon	Southeastern U. S.	Minimal

APPENDIX - C (continued)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Milksnake *Lampropeltis triangulum*	Varied habitats through east Texas	East Texas	Uncommon	Mainly east of the Mississippi	Minimal
Eastern coachwhip *Masticophis flagellum*	Open grasslands and semideserts	East Texas	Very Common	Southern half of U.S.	Minimal
Central Texas whipsnake *Masticophis taeniatus*	Varied	Central and west Texas	Uncommon	Central & west Texas into Mexico	Minimal
Brazos water snake *Natrix harteri*	Along the Brazos River	Along the Brazos River in central Texas	Uncommon	Central Texas	Minimal
Red-bellied watersnake *Natrix erythrogaster*	Rivers, swamps, and other aquatic regions	Statewide	Common	Southern Delaware to northern Florida and southeastern Alabama	Minimal
Diamond-backed watersnake *Natrix rhombifera*	Lakes, rivers, ditches, and cattle tanks	Statewide, except far west Texas and west panhandle	Common	Iowa to Gulf; Alabama to central Texas and northeast Mexico	Minimal
Rough greentree snake *Opheodrys aestivus*	Climbs among trees, vines, shrubs, and enters water	Statewide, except west Texas and panhandle	Common	New Jersey to Florida; Kansas to Texas	Minimal
Bull snake *Pituophis melanoleucus*	Plains and prairies, sandy areas with vegetation	Statewide	Common	Indiana & Wisconsin, south to Texas & eastern Mexico	Minimal
Long-nosed snake *Rhinocheilus lecontei*	Deserts and dry prairies among rocks or debris	Statewide, except east Texas	Common	Southwest Kansas to northeastern Mexico and west to New Mexico	Minimal
Patch-nose snake *Salvadora grahamiae*	Prairies, rugged rocky terrain, and brushlands	Statewide, except panhandle and east Texas	Uncommon	North central Texas south into Mexico	Minimal
Ground snake *Sonora episcopa*	Under stones on rocky hillsides, under boards or trash	Statewide, except east Texas	Common	Kansas to northeast Mexico and the Big Bend	Minimal
Brown snake *Storeria dekayi*	Parks, cemeteries, in trash, and large urban areas	East central, southeast, and south Texas	Uncommon	Minnesota to Texas and northeastern Mexico	Minimal
Flat-headed snake *Tantilla gracilis*	Under rocks where there is at least some moisture	Statewide, except panhandle and west Texas	Common	Southwestern Arkansas and southeastern Oklahoma to south Texas	Minimal

APPENDIX - C (continued)

Species	Habitat	Range in Region or State	Abundance in Region	Range in the United States	Project Impact
Black-headed snake *Tantilla nigriceps*	Under rocks, debris, etc. Rarely in the open	Statewide, except east Texas	Uncommon	Southwestern Oklahoma to extreme south Texas	Minimal
Checkered garter snake *Thamnophis marcianus*	Streambeds, springs, close to water	Statewide, except east Texas	Common	Southwest Kansas to northern Mexico, west to California	Minimal
Ribbon snake *Thamnophis proximus*	Semi-aquatic, close to streams and other bodies of water	Statewide	Very Common	Wisconsin & Colorado south to Louisiana, Texas, and eastern Mexico	Minimal
Lined snake *Tropidoclonion lineatum*	City lots, trash dumps, public parks, open prairies, timbered areas	Central and north central Texas	Uncommon	Central Illinois to Colorado & New Mexico; southeast South Dakota to central Texas	Minimal
Southern copperhead *Agkistrodon contortrix*	Lowlands; ground near swamps and streams	Statewide, except far west & south Texas, and panhandle	Common	South Kansas through Oklahoma & central Texas to the Gulf	Minimal
Western diamond-backed rattlesnake *Crotalus atrox*	Lowlands, desert flats, rocky cliffs, and canyons	Statewide, except east Texas	Common	Central Arkansas & Texas to California; south into northern Mexico	Minimal

*References numbers 5, 32, and 33 in the bibliography
#References numbers 2, 17, and 21 in the bibliography

APPENDIX - D

BIOLOGICAL INVENTORY - BIRD SPECIES

Species	Seasonal Status in Project Area*	Range in State#	Abundance in Region*	Range in the United States#	Project Impact
Common loon Gavia immer	Casual visitor, winter	Migrant over much of State mainly eastern part	Uncommon	Nationwide, except for arid southwest	Minimal
Horned grebe Podiceps auritus	Migrant, winter	Transient in most areas, Gulf Coast	Common	Northern United States	Minimal
Pied-billed grebe Podilymbus podiceps	Migrant, winter	Migrant through much of State, mainly south Texas	Common	North central United States	Minimal
White pelican Pelecanus erythrorhynchos	Migrant	Gulf coast	Irregular	West and central United States	Minimal
Double crested cormorant Phalacrocorax auritus	Migrant, winter	East & central Texas	Uncommon	Most of North America	Minimal
Anhinga Anhinga anhinga	Migrant	Northwest & central Texas	Rare	California, Arizona, New Mexico, Colorado, and Texas	Minimal
Great blue heron Ardea herodias	Resident	Resident throughout most sections	Uncommon	Most of North America	Minimal
Green heron Butorides vivescens	Summer	Most of state, more common eastern part	Uncommon	Northwest United States, eastern Canada to northern South America	Minimal
Little blue heron Florida caerulea	Migrant, summer	East, central and coastal sections	Uncommon	Eastern United States south to Peru	Minimal
Cattle egret Bulbulcus ibis	Migrant	Coastal and perhaps other parts of the State	Uncommon	Southwestern United States	Minimal
Common egret Casmerodious albus	Migrant	East and south Texas	Uncommon	Northern United States south to the Strait of Magellan	Minimal
Snowy egret Egretta thula	Migrant	East and south Texas	Uncommon	Northern United States to Chile	Minimal
Black-crowned night heron Nycticorax nycticorax	Summer	Most of State, mainly the coast	Uncommon	Canada south to South America	Minimal
Yellow-crowned night heron Nyctanassa violacea	Summer migrant	Eastern two-thirds of Texas, winters on coast	Uncommon	Northeastern United States south to Peru and Brazil	Minimal

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Least bittern *Ixobrychus exilis*	Migrant	Eastern half and locally in panhandle and at El Paso	Uncommon	Northwestern United States	Minimal
American bittern *Botaurus lentiginosus*	Migrant	Most sections in summer, winters along the coast	Uncommon	Canada south to the Gulf states	Minimal
White-faced ibis *Plegadis chihi*	Migrant	Coast, north and west Texas, panhandle	Uncommon	Southern United States	Minimal
Canada goose *Branta canadensis*	Migrant	Migrant throughout, along coast and locally inland	Common	Northern United States	Minimal
White-fronted goose *Anser albifrons*	Migrant	Most of State except trans-Pecos, mainly Gulf coast	Uncommon	Gulf states	Minimal
Blue-snow goose *Chen caerulescens*	Migrant	Eastern half of State and entire coast	Uncommon	Gulf of Mexico	Minimal
Mallard *Anas Platyrhynchos*	Migrant	North in summer, winter migrates throughout State	Common	Nationwide	Minimal
Gadwall *Anas strepera*	Winter	Throughout the State	Common	Northern United States	Minimal
Pintail *Anas acuta*	Winter	Statewide	Common	Nationwide	Minimal
Green-winged teal *Anas crecca*	Winter	Statewide	Common	West and northeast United States	Minimal
Blue-winged teal *Anas discors*	Winter	Migrant throughout, winters along coast and into north Texas	Common	Canada south to southern United States	Minimal
Cinnamon teal *Anas cyanoptera*	Winter	Migrant throughout, winters in south Texas and along the coast	Uncommon	Southwestern United States	Minimal
American wigeon *Mareca americana*	Winter	Statewide	Common	Northern United States to South and Central America	Minimal

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Shoveler Spatula clypeata	Winter	Statewide, except for panhandle and other cold sections	Common	Nationwide	Minimal
Redhead Aythya americana	Migrant	Migrant statewide, winters on coast and locally inland	Common	Northwestern United States	Minimal
Ring-necked duck Aythya collaris	Winter	Migrant statewide, winters on coast and locally inland	Uncommon	Northern United States	Minimal
Canvasback Aythya valisineria	Winter	Migrant statewide, winters on coast and locally inland	Uncommon	Northwest United States	Minimal
Greater scaup Aythya marila	Winter	Panhandle and north Texas south to coast	Rare	Nationwide	Minimal
Lesser scaup Aythya affinis	Winter	Mainly along coast, inland to north Texas	Common	Nationwide	Minimal
Bufflehead Bucephala albeola	Winter	Along coast, inland to north and west Texas and the panhandle	Uncommon	Nationwide	Minimal
Ruddy duck Oxyura jamaicensis	Winter	Along coast and inland to north and west Texas	Common	Nationwide	Minimal
Hooded merganser Lophodytes cucullatus	Migrant	Along coast, eastern half of State and panhandle	Rare	Northern United States to Gulf Coast	Minimal
Turkey vulture Cathartes aura	Resident	Statewide, except in panhandle, trans-Pecos, and Staked Plains in winter	Common	South Canada south to Strait of Magellan	Minimal
Black vulture Coragyps atratus	Resident	Statewide, except Staked Plains	Uncommon	Ohio and Maryland to Chile and Argentina	Insignificant
Mississippi kite Ictinia mississippiensis	Summer	Statewide, except trans-Pecos	Uncommon	Mainly south central United States	Insignificant
Sharp-shinned hawk Accipiter striatus	Winter	Winters stateside, breeds in northern half of State	Uncommon	Most of North America	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Cooper's hawk *Accipiter cooperii*	Winter	Breeds statewide, winters statewide, except panhandle	Uncommon	Southern Canada south to northern Mexico	Insignificant
Red-tailed hawk *Buteo jamaicensis*	Resident	Winters statewide, summers may be rare in Rio Grande delta	Uncommon	Alaska and Canada south to Panama	Insignificant
Red-shouldered hawk *Buteo lineatus*	Resident	Locally eastern half of state. Occurs west (rarely) to panhandle, Del Rio and Rio Grande valley	Rare	Southern Canada south to Mexico	Insignificant
Swainson's hawk *Buteo swainsoni*	Migrant	Statewide, summers through western half of state east to Fort Worth and Waco	Common	Western North America, winters in Argentina	Insignificant
Rough-legged hawk *Buteo lagopus*	Winter	Rare visitor of scattered occurrence, recorded south to Brownsville	Rare	Arctic, south to southern United States, central Eurasia	Insignificant
Ferruginous hawk *Buteo regalis*	Winter	Panhandle, plains, and trans-Pecos to central coast	Rare	Southwestern Canada south to northern Texas	Insignificant
Marsh hawk *Circus cyaneus*	Winter	Winters statewide, summers locally in northern half of State	Common	Alaska, Canada, south to southern United States	Insignificant
Osprey *Panpion haliaetus*	Migrant	Statewide, but winters very rarely along coast	Rare	Almost cosmopolitan, migratory	Insignificant
Pigeon hawk *Falco columbarius*	Winter	Throughout most sections, less common westward	Rare	Northern parts of Northern Hemisphere	Insignificant
Sparrow hawk *Falco sparverius*	Winter	Statewide, breeds in eastern, northern, and western parts	Common	Most of North and South America	Insignificant
Bobwhite *Colinus virginianus*	Resident	Statewide, except Staked Plains and trans-Pecos	Common	Central and eastern United States south to Guatamala	Minimal

APPENDIX - D (*continued*)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Sandhill crane *Grus canadensis*	Migrant	Statewide, widely along coastal prairie and locally along Rio Grande, and in south Texas	Common	Canada south to northern United States, also southeastern United States and Cuba	Insignificant
Sora *Porzana carolina*	Migrant	Statewide, winters along coast, rarely in central Texas and panhandle	Uncommon	Canada south to southeastern United States	Insignificant
Purple gallinule *Porphyrula martinica*	Summer	Summers in eastern half of state, most frequent near coast, casual in panhandle	Rare	Southeastern United States south to Argentina	Insignificant
Common gallinule *Gallinula chloropus*	Summer	In eastern half of State winters near coast and along Rio Grande	Rare	Southern Canada south to South America	Insignificant
American coot *Fulica americana*	Winter	Statewide	Common	Canada south to Ecuador	Insignificant
Semipalmated plover *Charadrius semipalmatus*	Migrant	In eastern half of state, Staked Plains and panhandle, numerous on the coast	Rare	Arctic south to South America	Insignificant
Killdeer *Charadrius vociferus*	Resident	Statewide	Common	Canada south to central Mexico	Insignificant
Common snipe *Capella gallinago*	Winter	Statewide	Common	North America to northern Eurasia	Insignificant
Long-billed curlew *Numenious americanus*	Migrant	Throughout much of State but breeds only in northwestern panhandle	Rare	Southwestern Canada and western	Insignificant
Upland plover *Bartramia longicauda*	Migrant	Statewide, except trans-Pecos and northern panhandle	Common	Canada and northern United States	Insignificant
Spotted sandpiper *Actitis macularia*	Migrant	Statewide, breeds in panhandle and north Texas	Uncommon	Northern Alaska and Canada south to central United States	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Solitary sandpiper *Iringa solitaria*	Migrant	Statewide, a few winter near the coast	Uncommon	Alaska and Canada south to Argentina	Insignificant
Willett *Catoptrophorus semipalmatus*	Migrant	Most sections and along the coast	Rare	Southern Canada south to Gulf states and the West Indies	Insignificant
Greater yellowlegs *Totanus melanoleucus*	Migrant	Most parts of the State	Common	Alaska and Canada south to Tierra del Fuego	Insignificant
Lesser yellowlegs *Totanus flavipes*	Migrant	Most parts of State, winters along coast and in southern half of State	Common	Alaska and Canada south to Argentina	Insignificant
Pectoral sandpiper *Calidris melanotos*	Migrant	Statewide, except trans-Pecos (probably casual there)	Uncommon	Arctic and Siberia south to southern South America	Insignificant
White-rumped sandpiper *Calidris fuscicollis*	Migrant	Throughout most sections, casual in winter on coast	Rare	Arctic America south to South America	Insignificant
Baird's sandpiper *Calidris bairdii*	Migrant	Statewide, most numerous in panhandle and in southern Staked Plains	Common	Arctic and Siberia, winters in Andes	Insignificant
Least sandpiper *Calidris minutilla*	Migrant	Statewide, mainly along coast; inland to northeast, north central, and west Texas	Common	Alaska and Canada south to South America	Insignificant
Semipalmated sandpiper *Calidris dusillus*	Migrant	Through most sections winters along coast	Common	American Arctic to southern United States and South America	Insignificant
Western sandpiper *Calidris mauri*	Migrant	Statewide, winters along coast and in west Texas	Common	Alaska to southern United States and South America	Insignificant
Nashville warbler *Vermivora ruficapilla*	Migrant	Statewide	Uncommon	South in mountains to central California and northeast West Virginia	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Yellow warbler *Dendroica petechia*	Migrant	Statewide	Uncommon	South in mountains to central California	Insignificant
Magnolia warbler *Dendroica magnolia*	Migrant	Throughout eastern half, rare in panhandle	Rare	Canada south to northeastern United States and mountains of West Virginia	Insignificant
Myrtle warbler *Dendroica coronata*	Winter	Statewide, but scarce in extreme west Texas	Common	Canada south to northeastern edge of the United States	Insignificant
Black throated green warbler *Dendroica virens*	Migrant	Eastern two-thirds of State; west to panhandle	Uncommon	Northeastern U.S. south to northern Georgia; south Texas	Insignificant
Chestnut-sided warbler *Dendroica pensylvanica*	Migrant	Eastern half of State; west to Fort Worth, Austin, San Antonio, and Uvalde	Rare	Northeastern U.S.; south in mountains to northern Georgia	Insignificant
Yellowthroat *Geothlypis trichas*	Winter	Statewide, except colder northern and western areas	Uncommon	Nationwide	Insignificant
Yellow-breasted chat *Icteria virens*	Migrant	Statewide, except for Staked Plains	Rare	Nationwide	Insignificant
Wilson's warbler *Wilsonia pusilla*	Migrant	Statewide	Common	Canada south to California, New Mexico, in the east to northern New England	Insignificant
House sparrow *Passer domesticus*	Resident	Statewide	Rare	Nationwide	Insignificant
Eastern meadowlark *Sturnella magna*	Winter	Eastern half of State, west locally to east panhandle	Common	Canada south through eastern U.S. to Gulf states	Insignificant
Western meadowlark *Sturnella neglecta*	Winter	Statewide, but rare on eastern edge	Common	Canada south through western U.S. to central Mexico	Insignificant
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	Migrant	western three-fourths of State, east to Commerce, Tyler, Bryan, Galveston and Corpus Christi	Uncommon	Canada to northwest Mexico	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Red-winged blackbird *Euphagus cyanocephalus*	Resident	Statewide	Common	Nationwide	Insignificant
Boat-tailed grackle *Cassidix mexicanus*	Resident	Statewide, but usually avoids east Texas forests	Common	New Jersey coast south to Texas	Insignificant
Brown-headed cowbird *Molothrus ater*	Resident	Statewide	Common	Southern Canada south to northern Mexico	Insignificant
American redstart *Setophaga ruticilla*	Migrant	Statewide, but less frequent in western parts	Rare	Canada south to northeast Texas, Louisiana, and northern Georgia	Insignificant
Summer tanager *Piranga rubra*	Summer	Trans-Pecos, occasionally along lower coast	Uncommon	Southwestern U.S. south to northern Argentina	Insignificant
Hermit thrush *Hylocichla guttata*	Resident	Statewide, but scarce in panhandle and colder areas	Common	Southwestern U.S. and eastern West Virginia	Insignificant
Swainson's thrush *Hylocichla ustulata*	Migrant	Probably throughout, less frequent in western parts	Uncommon	Canada south to California, Colorado, and in the east to the mountains of Virginia	Insignificant
Eastern bluebird *Sialia currucoides*	Resident	Eastern two-thirds of State from panhandle to the valley	Uncommon	East of Rockies south to the Gulf states, east of Arizona	Insignificant
Mountain bluebird *Sialia currucoides*	Winter	Western two-thirds of State and to central coast	Rare	Western Canada to California, northern Arizona	Insignificant
Blue-gray gnatcatcher *Polioptila caerulea*	Migrant	Statewide	Common	Southern Utah and Lake Erie south to Guatemala	Insignificant
Golden-crowned kinglet *Regulus satrapa*	Winter	Statewide	Uncommon	Nationwide	Insignificant
Water pipit *Anthus spinoletta*	Winter	Statewide, except in panhandle	Uncommon	High mountains of western U.S.	Insignificant
Cedar waxwing *Bombycilla cedrorum*	Winter	Statewide	Common	Canada south to northern California, western Oklahoma and Georgia	Insignificant
Loggerhead shrike *Lanius ludovicianus*	Resident	Statewide	Common	Canada south to Mexico and Gulf states	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Starling Sturnus vulgaris	Resident	Statewide	Common	Nationwide	Insignificant
Black-capped vireo Vireo atricarilla	Summer	Edwards Plateau east to Dallas, Austin, and San Antonio	Rare	Southwestern Kansas south to Texas and Coahiula	Insignificant
Bell's vireo Vireo bellii	Summer	Statewide, except upper coastal sections and lower valley	Rare	Midwestern and southwestern U.S.	Insignificant
Solitary vireo Vireo solitarius	Migrant	Statewide	Uncommon	Nationwide	Insignificant
Red-eyed vireo Vireo olivaceus	Migrant	Statewide, except trans-Pecos	Rare	Canada south to Gulf states	Insignificant
Warbling vireo Vireo gilvus	Migrant	Statewide	Rare	Canada south to southern U.S. and northern Mexico	Insignificant
Black and white warbler Mniotilta varia	Migrant	Statewide	Uncommon	Canada south to Gulf states	Insignificant
Tennessee warbler Vermivora peregrina	Migrant	Through eastern half: west of Fort Worth, Austin, and San Antonio	Rare	Northeastern edge of U.S.	Insignificant
Orange-crown warbler Vermivora celata	Migrant	Statewide	Uncommon	Throughout most of western U.S.	Insignificant
Cardinal Cardinalis cardinalis	Resident	Throughout most of State	Common	Canada south to Gulf states	Insignificant
Rose-breasted grosbeak Pheucticus ludovicianus	Migrant	Eastern and coastal Texas	Rare	East of Rockies south to eastern Kansas, Missouri, and Georgia	Insignificant
Blue grosbeak Guiraca caerulea	Migrant	Most sections of Texas	Rare	California across U.S. to southern	Insignificant
Painted bunting Passerina ciris	Summer	Throughout most of State	Common	Across southern U.S.	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Dickcissel Spiza americana	Summer	Through eastern two-thirds of State	Common	Western Montana, southern Ontario to Louisiana and Texas	Insignificant
Pine siskin Spinus pinus	Winter	Northern half of State, rare in the south	Common	Alaska, Canada, and northeastern United States	Insignificant
American goldfinch Spinus tristis	Winter	Throughout the State	Common	Southern Canada to northern Baja, California, southern U.S.	Insignificant
Rufous-sided towhee Piplio erythrophthalmus	Winter	Throughout the State	Common	Southern Canada south to eastern Gulf Coast	Insignificant
Lark bunting Calamospiza melanocorys	Winter	Western part of State, irregular in eastern part	Common	Prairies to southern Canada, south to north Texas	Insignificant
Savanna sparrow Passerculus sandwichensis	Winter	Throughout the State	Common	North Alaska across Canada to northern U.S.	Insignificant
Grasshopper sparrow Ammodramus savannarum	Resident	Throughout State	Uncommon	Southern Canada south locally to southern U.S.	Insignificant
Vesper sparrow Pooecetes gramineus	Resident	Throughout State	Common	Canada south to southwestern states, Missouri	Insignificant
Rufous-crowned sparrow Aimophila ruficeps	Resident	Trans-Pecos and Edwards Plateau, east to Fort Worth, Austin	Uncommon	Southwestern U.S. to southern Mexico	Insignificant
Cassin's sparrow Aimophila Cassinii	Summer	Statewide	Uncommon	Nevada, Kansas, south to northern Mexico	Insignificant
Chipping sparrow Spizella passerina	Migrant	Statewide	Common	Canada to Nicaragua	Insignificant
Clay-colored sparrow Spizella pallida	Migrant	South Texas	Common	Western Canada to north central U. S.	Insignificant
Long-billed dowitcher Limnodromus scolopaceus	Migrant	Throughout much of State; winters on coast	Common	Siberia, Alaska, and Canada to Guatemala	Insignificant
Stilt sandpiper Micropalama himantopus	Migrant	Statewide, winters occasionally on coast	Rare	American arctic to South America	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Buff-breasted sandpiper *Tryngites subruficollis*	Migrant	East, central and northern Texas, most frequent along the coast	Rare	American Arctic to South America	Insignificant
American avocets *Recurvirostra americana*	Migrant	Statewide	Common	Southwestern Canada, western U.S. to Guatemala	Insignificant
Black-necked stilt *Himantopus mexicanus*	Migrant	Along coast, south, west, and central Texas	Rare	Western U.S. and Gulf states south to northern South America	Insignificant
Wilson's phalarope *Steganopus tricolor*	Migrant	Statewide	Common	Southwestern Canada and western U.S. to southern South America	Insignificant
Herring gull *Larus delawarensis*	Winter	Along coast and west to panhandle	Uncommon	Cooler parts of northern hemisphere	Insignificant
Franklin's gull *Larus pipixcan*	Winter	Throughout most of State, rare in trans-Pecos	Common	Northwest and north central U.S. to Guatemala	Insignificant
Forster's tern *Sterna forster*	Migrant	Along coast, local in central and west Texas, uncommon in north Texas	Rare	Western Canada south to northern Tamaulipas	Insignificant
Black tern *Chlidonias niger*	Migrant	Through most parts, winters on coast	Uncommon	North America to southern hemisphere	Insignificant
Rock dove *Columba livia*	Resident	About many cities throughout the State	Common	World-wide	Insignificant
Mourning dove *Zenaida macroura*	Resident	Statewide	Common	Nationwide	Insignificant
Inca dove *Scadafella inca*	Winter	Mainly southern Texas along the coast and some inland to Austin	Rare	Southwestern U.S. south to northwest Costa Rica	Insignificant
Yellow-billed cuckoo *Coccyzus americanus*	Summer	Statewide	Common	Southern Canada south to Mexico	Insignificant
Black-billed cuckoo *Coccyzus erythrophthalmus*	Migrant	Through eastern and central Texas, west to Fort Worth, Austin, Del Rio, and panhandle	Rare	Southern Canada south to Nebraska, Arkansas, South Carolina	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Roadrunner *Geococcyx californianus*	Resident	Every section, less frequent in eastern parts	Uncommon	Southwestern U.S. south to central Mexico	Insignificant
Barn owl *Tyto alba*	Resident	Statewide, except in mountains	Rare	Southern Canada to Tierra del Fuego	Insignificant
Screech owl *Otus asio*	Resident	Statewide	Uncommon	Alaska, southern Canada south to central Mexico	Insignificant
Great horned owl *Bubo virginianus*	Resident	Statewide	Uncommon	Limit of trees in Arctic to Strait of Magellan	Insignificant
Burrowing owl *Speotyto cunicularia*	Resident	Throughout the state, more frequent westward	Uncommon	Southwestern Canada and Florida, south locally to Tierra del Fuego	Insignificant
Barred owl *Strix varia*	Resident	East, north, and central Texas, west to the panhandle, south to Corpus Christi	Rare	Canada to Honduras	Insignificant
Short eared owl *Asio flammeus*	Winter	Throughout much of State	Uncommon	Arctic south to central U.S.	Insignificant
Chuck-will's-widow *Caprimulgus carolinensis*	Summer	East, northeast, and central Texas	Rare	Southern U.S. from Kansas, New Jersey south to Gulf States	Insignificant
Poor-will *Phalaenoptilus nuttallii*	Summer	East, central, and south Texas	Rare	British Columbia south to central Mexico	Insignificant
Common nighthawk *Chordeiles minor*	Summer	In all sections	Common	Canada south to southern Mexico	Insignificant
Chimney swift *Chaetura pelagica*	Summer	Statewide except trans-Pecos	Common	Canada to Gulf states	Insignificant
Ruby-throated hummingbird *Archilochus colubris*	Summer	Eastern two-thirds of State west to Pecos River and panhandle	Uncommon	Southern Canada south to Gulf states	Insignificant
Black-chinned hummingbird *Archilochus alexandri*	Summer	Western and central parts; east to Dallas, Austin, and San Antonio	Uncommon	Southwestern British Columbia south to northern Mexico	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Belted kingfisher *Megaceryle alcyon*	Resident	Throughout much of State	Common	Alaska, Canada, south to southern U.S. and Panama	Insignificant
Common flicker *Colaptes auratus*	Winter	Throughout much of State	Common	Tree-limit in Alaska south to Gulf states; Cuba	Insignificant
Red-bellied woodpecker *Centurus carolinus*	Resident	East Texas west to panhandle, south to central coast	Uncommon	Great Lakes to Florida and Gulf coast	Insignificant
Golden-fronted woodpecker *Centurus aurifron*	Resident	Mid-regions	Uncommon	Southwestern Oklahoma south to Nicaragua	Insignificant
Red-headed woodpecker *Melanerpes erysthrocephalus*	Transient	East and central Texas; west to panhandle and Corpus Christi	Rare	Southern Canada, east of Rockies south to Gulf states	Insignificant
Yellow-bellied sapsucker *Sphyrapicus varius*	Winter	Statewide	Uncommon	Alaska, central Canada south to southwestern U.S. and Georgia	Insignificant
Hairy woodpecker *Dendrocopos villoscens*	Resident	Wooded sections of east and north Texas; south to Waco, Houston, Rockport	Uncommon	Alaska, Canada, south to Mexico	Insignificant
Downy woodpecker *Dendrocopos pubescens*	Transient	East, north and central Texas; west to panhandle; south to coast	Rare	Alaska, Canada, south to Gulf states and southwestern U.S.	Insignificant
Ladder-backed woodpecker *Dendrocopos scalaris*	Resident	Western two-thirds of State from panhandle to Brownsville, east to Dallas	Uncommon	Southwestern U.S. south to British Honduras	Insignificant
Eastern kingbird *Tyrannus tyrannus*	Summer	Statewide, except trans-Pecos; most numerous along coast	Uncommon	Central Canada south to Gulf of Mexico	Insignificant
Western kingbird *Tyrannus verticalis*	Summer	Statewide	Common	Southwestern Canada south to Mexico	Insignificant
Scissor-tailed flycatcher *Muscivora forficata*	Summer	Statewide, except extreme western tip, (casual at El Paso)	Common	Southeastern Colorado, southern Nebraska, south to south Texas, southern Mexico, and Panama	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Eastern phoebe Sayornis phoebe	Winter	Statewide, except trans-Pecos	Uncommon	Central Canada south to central Texas, southern Mexico	Insignificant
Willow flycatcher Empidonax traillii	Migrant	Probably throughout	Uncommon	Eastern, central, and southwestern United States	Insignificant
Least flycatcher Empidonax minimus	Migrant	Throughout most of State, west to Big Bend and panhandle	Uncommon	North central and northeastern U.S.	Insignificant
Western flycatcher Empidonax difficilis	Migrant	Through trans-Pecos, Southern Plains, and along the Rio Grande	Rare	Western North America to Honduras	Insignificant
Eastern wood pewee Contopus viren	Summer	Eastern and central Texas; west to Edwards Plateau, south to Victoria	Rare	Southern Canada south to Gulf states	Insignificant
Olive-sided flycatcher Contopus sordidulus	Migrant	Statewide	Rare	Canada, south to the mountains of southwestern U.S. and South America	Insignificant
Yellow-bellied flycatcher Empidonax flaventris	Migrant	Through eastern half of State	Rare	Canada south to northern edge of central and eastern U.S., Mexico and Panama	Insignificant
Horned lark Eremophila alpestris	Winter	Statewide	Common	Northern hemisphere	Insignificant
Bank swallow Riparia riparia	Migrant	Statewide	Uncommon	Northern hemisphere, South America	Insignficant
Rough-winged swallow Stelgidopteryx ruficollis	Migrant	Locally throughout the State; winters along the coast	Common	Southern Canada south to Argentina	Insignificant
Barn swallow Hirunda rustica	Migrant	Statewide	Common	Northern hemisphere to South America	Insignificant
Cliff swallow Petrochelidon pyrrhonota	Summer	Locally, except in east Texas and upper coast	Common	Alaska, Canada, south to central Mexico	Insignificant
Purple martin Progne subis	Summer	Throughout most of State, rare in west Texas	Common	Southern Canada wouth to northwestern Mexico and Gulf states	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Blue jay Cyanocitta cristata	Resident	Panhandle and north and east Texas; south to Houston and San Antonio	Common	Southern Canada, east of Rockies, south to Gulf states	Insignificant
Common crow Corvus brachyrhynchos	Resident	Eastern and northern Texas west to panhandle, south to upper coast	Common	Canada south to southwestern U.S. and Gulf states	Insignificant
Carolina chickadee Parus carolinensis	Resident	Eastern, northern and central Texas, west to panhandle, south to San Antonio	Common	Central U.S. south to Gulf states	Insignificant
Tufted titmouse Parus bicolor	Resident	Eastern half of State, west to Austin and central coast	Common	South through eastern U.S. to Gulf states	Insignificant
Verdin Auriparus flaviceps	Resident	Trans-Pecos east to Austin south to central coast	Uncommon	Southwestern U.S. south to central Mexico	Insignificant
Red-breasted nuthatch Sitta canadensis	Winter	Most frequent in east Texas, straggler in southern part of State	Rare	Canada south in mountains to southwestern U.S. and western North Carolina	Insignificant
Brown creeper Certhia familiaris	Winter	Statewide, but rare in southern part of State	Uncommon	Alaska, Canada, to Gulf states	Insignificant
House wren Trolopytes aedon	Winter	Statewide, except in panhandle and colder northern counties	Uncommon	Southwestern U.S. and central parts of eastern U.S.	Insignificant
Winter wren Troglodytes troglodytes	Winter	Throughout most of State, most frequent in northern parts	Uncommon	Western hemisphere south to southern U.S.	Insignificant
Bewick's wren Thryomanes bewickii	Resident	Statewide, except counties in eastern part and upper coast	Common	Canada south through middle and western U.S. to south central Mexico	Insignificant
Carolina wren Thryothorus ludovicianus	Resident	Eastern two-thirds of State; visitor to panhandle	Common	Ontario and New England south to northeastern New Mexico and Gulf states	Insignificant
Canon wren Catherpes mexicanus	Resident	Panhandle, west Texas, and Edwards Plateau	Rare	Southwestern Canada south through western U.S. to southern Mexico	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Long-billed marsh wren *Telmatodyttos palustris*	Winter	Statewide, except panhandle and colder northern parts	Rare	Southern Canada south to Mexico and Gulf coast	Insignificant
Mockingbird *Mimus polyglottos*	Resident	Statewide	Common	Southern Canada south to southern Mexico	Insignificant
Catbird *Dumetella carolinensis*	Migrant	Through southern two-thirds of State, west to panhandle and Edwards Plateau	Uncommon	Southern Canada south to northeastern New Mexico and Gulf states	Insignificant
Brown thrusher *Toxostoma rufum*	Resident	Panhandle and north and east Texas, rarely south to Waco	Uncommon	Southern Canada, east of Rockies to Gulf states	Insignificant
Robin *Turdus migrator*	Winter	Statewide	Common	Canada south to southern Mexico and Gulf states	Insignificant
Wood thrush *Hylocichla mustelina*	Migrant	Through eastern half, west to eastern panhandle and lower Rio Grande	Uncommon	Southeastern Canada south to Gulf states	Insignificant
Field sparrow *Spizella pusilla*	Winter	Statewide, except panhandle and extreme western part of State	Uncommon	Southeastern Canada through U.S., east of Rockies to Gulf states	Insignificant
Harris' sparrow *Zonotrichia querula*	Winter	East, north, and central Texas, west to panhandle, south to coast	Common	South central U.S.	Insignificant
White-crowned sparrow *Zonotrichia leucophrys*	Winter	Statewide	Common	South through western U.S. to California, Arizona, and New Mexico	Insignificant
White-throated sparrow *Zonotrichia albicollis*	Winter	Eastern two-thirds of State west to Edwards Plateau, rare in panhandle	Common	Canada to northeastern U.S. to Gulf coast, northeastern Mexico	Insignificant
Fox sparrow *Passerella iliaca*	Winter	Eastern, northern and central Texas west to Austin, south to upper coast	Uncommon	Canada south to western mountains to California and Colorado, southern United States	Insignificant
Lincoln's sparrow *Melospiza lincolni*	Winter	Statewide, except panhandle	Common	Canada to northeastern U.S., south to southwestern U.S.	Insignificant

APPENDIX - D (continued)

Species	Seasonal Status in Project Area	Range in State	Abundance in Region	Range in the United States	Project Impact
Swamp sparrow *Melospiza georgiana*	Winter	Eastern half of State casual in Big Bend	Rare	Canada and northeastern United States to Gulf coast	Insignificant
Song sparrow *Melospiza melodia*	Winter	Statewide	Uncommon	Canada south through western U.S. to mountains of central Mexico, in eastern U.S. to mountains of Georgia	Insignificant
McCown's longspur *Calcarius mccownii*	Winter	Locally in western two-thirds of state, east to Commerce	Rare	Canada and north central U.S., southwestern U.S., & northern Mexico	Insignificant
Chestnut-collared longsupur *Calcarius ornatus*	Winter	Statewide, except eastern edge and southern tip of State	Rare	Canada, north central U.S., southwestern U.S. and northern Mexico	Insignificant
Ruby-crowned kinglet *Regulus calendula*	Winter	Statewide, except panhandle	Common	Alaska, Canada, south in mountains of California, Arizona, and New Mexico to Gulf states	Insignificant

*Reference number 18 in the bibliography
#Reference number 19 in the bibliography

APPENDIX - E

BIOLOGICAL INVENTORY - FISH SPECIES

Species	Abundance in Lake-1970* Percent Number	Percent Weight	Preferred or general habitat#	Abundance in Region*	Range in State@	Range in the United States#	Project Impact
Longnose gar *Lepisosteus osseus*	3.75	3.83	Warm, sluggish water	Common	Statewide	Minnesota to Vermont, south to Gulf & Rio Grande River	Insignificant
Gizzard shad *Dorosoma cepedianum*	31.31	13.59	Freshwater, may enter brackish water	Very Common	Statewide	Minnesota to New Jersey, south to Gulf and into Mexico	Insignificant
Small mouth buffalo *Ictiobus bubalus*	10.97	31.85	Large rivers and small lakes	Very Common	Statewide	Southern Minnesota to Michigan & south to Mexico	Insignificant
River carpsucker *Carpiodes carpio*	17.57	27.01	Rivers and lakes	Very Common	Statewide	Montana to Pennsylvania south to Tennessee & Texas	Insignificant
Carp *Cyprinus carpio*	2.50	6.41	Rivers & lakes; deposits eggs in shallow water	Common	Statewide	Widely introduced in the U.S. from Europe	Insignificant
Channel catfish *Ictalurus punctatus*	3.12	1.93	Flowing, clear waters of larger streams or rivers	Common	Statewide	Great Lakes south to Gulf of Mexico	Insignificant
Flathead catfish *Pylodictus olivaris*	1.87	7.09	Larger rivers	Common	Statewide	Mississippi Valley into Mexico	Insignificant
White bass *Morone chrysops*	5.00	1.82	Deep, still water of lakes	Common	Statewide except trans-Pecos region	Minnesota, east through Great Lakes; south to Alabama and Texas	Insignificant
Large mouth bass *Micropterus salmoides*	3.39	1.43	Clear, running streams and clearer, colder lakes	Common	Statewide	Minnesota to Quebec, south to Arkansas and northern Oklahoma	Insignificant
Warmouth *Chaenobryttus gulosus*	0.36	0.05	Bayous, sluggish streams and shallow mud-bottomed ponds and lakes	Common	Statewide	South Minnesota & Great Lakes south to Texas & Florida	Insignificant
Green sunfish *Lepomis cyanellus*	0.45	0.07	Warmer lakes and streams	Common	Statewide	Minnesota & Great Lakes south to Mexico; not east of the Allegheny Mountains	Insignificant
Redear sunfish *Lepomis microlophus*	0.71	0.13	Lakes, ponds, and streams	Common	Statewide rare in trans-Pecos region	Missouri to southern Indiana, south to Florida and Texas	Insignificant

APPENDIX - E (continued)

Species	Abundance in Lake-1970 Percent Number	Percent Weight	Preferred or general habitat	Abundance in Region	Range in State	Range in the United States	Project Impact
Bluegill sunfish *Lepomis macrochirus*	4.37	0.46	Lakes, ponds, and quiet streams	Very Common	Statewide	Widespread, from Minnesota to Florida and Texas	Insignificant
Longear sunfish *Lepomis megalotis*	1.16	0.07	Streams, especially clear brooks	Very Common	Statewide	Iowa to South Carolina and south Texas	Insignificant
White crappie *Pomoxis annularis*	10.26	2.60	Ponds, lagoons, bayous, and all sluggish waters	Very Common	Statewide except trans-Pecos region	Minnesota and Great Lakes south to Texas	Insignificant
Freshwater drum *Aplodinotus grunniens*	3.12	1.64	Larger lakes and lowland streams	Very Common	Statewide	Great Lakes south into Mexico	Insignificant
Golden shiner *Notemigonus crysoleucas*	0.09	0.02	Lakes, ponds, and streams	Common	Statewide not west of Edwards Plateau & high plains region	Canada to Florida and introduced west of Rockies	Insignificant

*Reference number 16 or 24 in the bibliography
#Reference numbers 9, 15, and 22 in the bibliography
@Reference number 13 in the bibliography

APPENDIX - F

BIOLOGICAL INVENTORY - AQUATIC VEGETATION

Species	Abundance in Lake - 1973	Range in Region or State*	Range in the United States*	Project Impact
Green algae Chlorophyta	Common	Throughout much of State	Throughout much of the U.S.	Insignificant
Stoneworts Chara	Common	Throughout much of State	Throughout much of U.S.	Insignificant
Narrow leaf cattail Typha	Abundant	Mainly south Texas	Canada south, South Carolina, West Virginia, Kentucky, Missouri, Nebraska, Texas and California	Insignificant
Smartweed Polygonum	Common	Mainly east, southeast and north central Texas	Throughout much of U.S.	Insignificant
Bulrushes Scirpus	Scattered	Primarily eastern half of State	Throughout much of U.S.	Insignificant
Pondweeds Potomogeton	Sparse	Most of State	Throughout much of U.S.	Insignificant

*Reference number 6 in bibliography


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